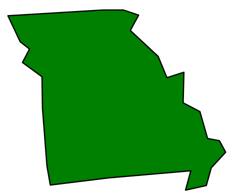
Missouri
Department of
Natural Resources

Appendix C - Area Sources

- The 1999 St. Louis Emissions Inventory Area Source Emissions Estimate
- NOX - Population, Employment & BEA
- VOC - Population, Employment & BEA

Missouri
Department of
Natural Resources

Air and Land Protection Division
Air Pollution Control Program



The 1999 St. Louis Area Emissions Inventory

Area Source Emissions Estimate

Prepared by:
Adel Alsharafi

TABLE OF CONTENTS

1.0 Introduction

1.1 Purpose of Study

The objective of this report is to document the 1999 base year inventory and projection years emissions for area sources of VOC and NOx for Missouri portion of St. Louis Metropolitan Statistical Area (MSA) Redesignation. Counties in MSA include Franklin, Jefferson, St. Charles, St. Louis and St. Louis City.

1.2 Sources of Emissions

For this inventory, emissions from area sources are estimated collectively for those sources and activities that are too small or too numerous to be handled individually in the point source inventory. Area sources of VOC and NOx emissions to be included in this inventory are shown in the following table:

Area Source Category	**Pollutant**	
	VOC	**NOx**
Dry Cleaning	X	
Architectural Surface Coating	X	
Auto Body Refinishing	X	
Graphic Arts	X	
Commercial/Consumer Solvent Use	X	
Solvent Cleaning	X	
Traffic Markings	X	
Bakeries	X	
Pesticide Application	X	
Gas Distribution	X	
Asphalt Paving	X	
Landfills	X	
Industrial Surface Coating	X	
On-site Incineration	X	X
Open Burning-RSW	X	X
Structure Fires	X	X
Forest/Wild Fires	X	X
Coal Combustion	X	X
Liquefied Petroleum Gas Combustion	X	X
Natural Gas Combustion	X	X
Fuel Oil Combustion	X	X
Residential Wood Combustion	X	X

1.3 Area Source Estimation Methodologies

Several methodologies were available for estimating the area source activity and emissions: (1) apportioning national or state activity totals to local inventory area; (2) using per capita emission factors; (3) using emissions-per-employee factors; (4) surveying local activity levels; and (5) treating area sources as point sources. Following the methodologies outlined in the Emission Inventory Improvement Program's (EIIP) guidance, appropriate data were collected for each source.

1.4 Rule Effectiveness

A rule effectiveness (RE) factor was applied to base year emissions for counties where regulations were in place. RE is a measure of the ability of a regulatory program to achieve all emissions reductions that could be achieved by full compliance with the applicable regulations at all sources at all times. It reflects the assumption that regulations are not 100% effective.

1.5 Double Counting of Emissions

A major concern in the development of an area source inventory is the possibility of double counting emissions. Because some area source methodologies estimate emissions from all sources within a category, emissions already listed in the point source inventory may also be included in the area source inventory. In developing the St. Louis area source inventory, possible double counting of emissions was avoided by subtracting emissions appearing in the Missouri state point source inventory from the area source totals for that category (*e.g.,* large dry cleaning facilities, large graphic arts facilities, *etc.*).

1.6 Emissions Adjustments and Projections

An essential element in an ozone control program is the emissions projections. Two types of projections can be made: baseline projections and control strategy projections. Baseline projections are estimates of emissions in some future year which take into account the effects of growth and existing control regulations. Control strategy projections are estimates of emissions in some future year which take additional control measures into consideration. Only baseline projections were estimated for this study.

1.6.1 Adjustment for Typical Summer Day

Because high photochemical ozone levels are generally associated with warmer months of the year and because VOC and NOx emissions from some sources vary seasonally, annual emissions are adjusted for a typical weekday during ozone season. The peak ozone season for the St. Lois study area is May through September. Base year emissions were adjusted for typical summer weekday using the EIIP guidance. The basic procedure consisted of multiplying the estimate of annual emissions by the seasonal adjustment factor given in the guidance and then dividing by the sum of the number of activity days per week multiplied by 52 weeks. This procedure can be expressed by the following equation:

$$\text{EmissionsperSummerDay} = \frac{\text{AnnualEmissionsxSeasonalAdjustmentFactor}}{\text{Numberof ActivityDays/Weekx 52 Weeks}}$$

1.6.2 Future Year Projections

Base year emissions for area source categories can be projected for future years based on population growth, growth in specific industries (identified by SCC) or overall industrial growth. Since most area source emission estimates were based on population, population growth factors were the most viable choice. For some cases where population was not used in the estimates, the Bureau of Economic Analysis' (BEA) growth factors were used.

1.7 Quality Assurance

To ensure that this emissions inventory if of high quality, certain quality assurance (QA) procedures were implemented at various points in the inventory process. The following quality assurance techniques were used:

- Each algorithm used to calculate emissions was reviewed to ensure its appropriateness and adherence to EIIP guidance.
- Each spreadsheet was reviewed to ensure the proper data, emission factors and algorithms were used.
- Peer review was an essential part of the QA
- All emissions estimates were checked for reasonableness.
- All emissions estimation methods, data collected and emissions calculations were reviewed again during the reporting stage.

1.8 Federal, State and Local Regulations

Federal, State of Missouri and St. Louis area air pollution regulations were reviewed for application to specific area source categories. As shown in the following sections, these regulations have contributed a lot to the emission reduction in St. Louis area. Categories addressed by these regulations include:

- Commercial and Consumer Products Solvent
- Auto Body Refinishing
- Underground Storage Tanks
- Vehicle Fueling
- Tank Truck Unloading
- Solvent Metal Cleaning
- Dry Cleaning
- Cutback Asphalt Paving
- Open Burning
- Bakery Ovens
- Traffic Coatings

2.0 Emissions Estimates

Emissions from each source Category are described in detail in the following sections. A brief description of the category is given, along with methodology used to estimate emissions, sources of data, emissions factors and sample calculation and results. Sample calculation shows ozone season day emissions in pounds.

2.1 Dry Cleaning

2.1.1 Source Description and Emission Control

Dry cleaning is considered a solvent evaporation emission source of VOC. It involves the cleaning of fabrics with non-aqueous organic solvent. The industry is divided into three sectors: coin-operated facilities; commercial operations; and industrial cleaners. Volatile organic solvents that are used as cleaning solvents are emitted during the dry cleaning process. The petroleum solvents most commonly used in dry cleaning are Stoddard solvent (mineral spirit) and 140-F. The synthetic solvents that are used in dry cleaning, PERC, TCA, and CFC-113, are not considered photochemically reactive and should not be included in an ozone inventory; PERC and TCA, however, are hazardous air pollutants that should be included in an air toxic inventory. TCA and CFC-113 are ozone-depleting substances, and CFC-113 may be listed in some state regulation as a toxic air pollutant. It is estimated that 80% of all dry cleaning facilities use PERC, 15% use petroleum solvents, 3% use CFC-113, and less than 1% use TCA. However, based on study of national solvent use, 57% of al dry cleaning solvents are petroleum solvents, 39% of the solvents are PERC, and 3 and 1% are TCA and CFC-113, respectively, with a minor amount of unspecified solvents. Small dry cleaning facilities, such as coin-operated sites use PERC exclusively, and larger facilities, such as commercial facilities use petroleum solvents, resulting in this disparity.

2.1.2 Emission Estimation Methodology

2.1.2.1 Activity Level

The number of employees in dry cleaning facilities with SIC 7216 was used to estimate VOC emissions. The number of employees was obtained from the U.S. Bureau of Census.[1]

2.1.2.2 Emission Factors

The Emission factor (1800 lb/employee) was obtained from EIIP, Dry Cleaning. This emission factor excludes emissions of PERC, TCA, and CFC 113.

2.1.2.3 Assumptions

It was assumed that coin-operated dry cleaners use PERC exclusively and 20 percent of the remaining dry cleaners use petroleum solvents. According to EIIP volume III[2], there is no seasonal adjustment factor for dry cleaning. In addition, the activity days per week are 5 days.

2.1.3 Emissions Projection

Table 1 shows employment growth factors taken from East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Dry Cleaning.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.1.4 Sample Calculation

OSD VOC emissions in pounds = [(# of employees) X (percent of facilities using petroleum solvents) X (emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Emission Factor: 1800 lb VOC/employee/yr

Number of Employees with SIC 7216 in Franklin County: 77

Percent of Facilities with SIC 7216 that use Petroleum Solvents: 20%

Activity Days Per Week: 5 days

Seasonal Activity factor: 0.25

OSD VOC = 77 employees X 0.2 X (1800 lb/employee/yr) / (5 days/week) X (1 year/52 weeks) X 0.25 / 0.25 = 106.62 lb/day

2.1.5 Results

Table 1: VOC Emissions from Dry Cleaners.

County	# Employees	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	77	106.62	N/A
Jefferson	45	62.31	N/A
St. Charles	202	279.69	N/A
St. Louis	1348	1866.46	N/A
St. Louis City	341	472.15	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Dry Cleaners.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	104.97	114.56	124.16
Jefferson	63.21	68.63	74.05
St. Charles	286.47	359.43	424.74
St. Louis	1866.46	1984.38	2046.27
St. Louis City	469.23	461.09	464.83

2.1.6 References

- [2]U.S. Census Bureau, Department of Commerce, Washington, D.C.
- [3]*Dry Cleaning*, Volume III: Chapter 5, Final Report, Area Sources Committee EIIP, May 1996.

2.2 Architectural Surface Coating

2.2.1 Source Description and Emission Control

Architectural surface coating is considered a solvent evaporation emission of volatile organic compounds (VOC) and is categorized as non-industrial surface coating. Architectural surface coatings, trade paints, are used primarily by homeowners and painting contractors to coat the interior and exterior of houses and buildings and the surfaces of other structures such as pavements, curbs and signs. Volatile organic compounds that are used as solvents in the coatings are emitted during the application of the coating and as the coating dries. The amount of coating used and the VOC content of the coating are the factors that primarily determine emissions from architectural surface coating operations. Secondary sources of VOC emissions are from the solvents used to clean the architectural coating application equipment and VOC released as reaction byproducts while the coating dries and hardens. The resins used in a particular coating determine VOC emitted from this chemical reaction. Since the use of organic solvents in architectural surface coatings is the primary source of emissions, control techniques for this source category involve either product substitution or product reformulation.

2.2.2 Emission Estimation Methodology

2.2.2.1 Activity Level

The Activity level is based on population and estimated gallons of paint (solvent and water based) used nation wide.[1]

2.2.2.2 Emission Factors

Emission factors for solvent based and water based paints are 3.87 lb/gallon and 0.74 lb/gallon respectively. All emission factors were obtained from EIIP volume III.[2]

2.2.2.3 Assumptions

A per capita emission factor was used to calculate emissions from this source category. This per capita usage factor is calculated by dividing the total usage of surface coating materials by the United States population. A seasonal activity factor of 0.33 was used for this category. Activity was also assumed to be uniform 365 days per year.

2.2.3 Emissions Projection

A discussion about developing growth factors and projecting emission estimates can be found in Section 4 of the EIIP Volume III, Chapter 1, and Introduction to Area Source Emission Inventory Development. Since the proportion of county to state population was used to estimate this area source emission, the projected emission estimates were calculated using the population-based growth factor data. The population projection factors were obtained from East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).[4]

Table 1: Growth Factors for Architectural Surface Coating.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.2.4 Sample Calculation

Using the alternative method from the EIIP Volume III, Chapter3[3], the estimated ozone season daily VOC emissions from the Franklin County inventory area can be illustrated as follows:

OSD VOC (Lb/day) = pollution of county X per capita emission factor X emission factor / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

US Population: 274360522

Total Paint-water based (gallons): 496991000

Total Paint-solvent based (gallons): 134302000

Per Capita-water based factor = 496991000 / 274360522 = 1.8115 gallons/person

Per Capita-water based factor = 134302000 / 274360522 = 0.4895 gallons/person

Paint-water based Emission Factor: 0.74 lb/gallon

Paint-solvent based Emission factor: 3.87 lb/gallon

Population of Franklin County, 1999: 91763

Activity Days Per Week: 7 days

Seasonal Activity Factor: 0.33

OSD VOC = 91763 persons X (1.8115 gal/person/yr X 0.74 lb/gal + 0.4895 gal/person/yr X 3.87 lb/gal) / (7 days/week) X (1yr/52 week) X 0.33 / 0.25 = 1076.46 lbs/day

2.2.5 Results

Table 1: VOC emissions from Architectural Surface Coating.

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	1076.46	N/A
Jefferson	195675	2295.44	N/A
St. Charles	272353	3194.94	N/A
St. Louis	998,696	11715.57	N/A
St. Louis City	339316	3980.47	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Architectural Surface Coating.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	1067.44	1210.73	1335.90
Jefferson	2296.59	2475.13	2653.67
St. Charles	3230.02	3708.54	4134.99
St. Louis	11773.67	11728.31	11644.90
St. Louis City	4111.41	4132.56	4153.34

2.2.6 References

- [1]U.S. Census Bureau, Department of Commerce, Washington D.C.
- [2,3]*Architectural Surface Coating*, Volume III: Chapter 5, Final Report, Area Sources Committee EIIP, August 1996.
- [4]East-West Gateway Coordinating Council, St. Louis, MO.

2.3 Auto Body Refinishing

2.3.1 Source Description and Emission Control

Auto body refinishing operations consist of four steps: (1) vehicle preparation, (2) primer application, (3) topcoat application, and (4) spray equipment cleaning. VOC emissions from automobile refinishing are influenced by several factors. Emissions from surface preparation and coating applications are a function of VOC content of the product used. Emissions are also a function of the transfer efficiency of the spray equipment. Transfer efficiency is the percent of paint solids that actually adheres to the surface being painted. Equipment with lower transfer efficiency would require more material to be sprayed, thus, increasing VOC emissions. Emissions from cleaning operations are dependent on the type of cleanup and housekeeping practices used. There are six main approaches for reducing VOC emissions from auto-body refinishing shops: use of lower-VOC coatings, use of enclosed cleaning devices, increased transfer efficiency, use of lower-VOC primers, use of solvent recovery system, and use of add-on controls for their spray booths such as thermal incineration, catalytic incineration, and carbon absorption. Other housekeeping activities can also be used to reduce emissions from auto body refinishing operations. These activities include tight fitting containers, reducing spills, mixing paint to need, providing training, maintaining rigid control of inventory, etc.

2.3.2 Emission Estimation Methodology

2.3.2.1 Activity level

The estimated national VOC emission from auto body refinishing was apportioned to inventory area using employment data with 7532 SIC obtained from Department of Commerce.

2.3.2.2 Emission Factors

The emission factor is the number of employees in the inventory area divided by the number of employees nationwide with 7532 SIC.

2.3.2.3 Assumptions

It was assumed that the National VOC emissions from auto body refinishing are directly proportional to employment. It was assumed that the national EPA regulation promulgated on September 11, 1998 to control VOC emissions from the use of Automobile refinishing coatings would reduce emission by 37%.

2.3.3 Emissions Projection

A discussion about developing growth factors and projecting emission estimates can be found in Section 4 of the EIIP Volume III, Chapter 1, and Introduction to Area Source Emission Inventory Development. Since the proportion of county to state population was used to estimate this area source emission, the projected emission estimates were calculated using the population-based growth factor data. The projection population data was obtained from East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Auto Body Refinishing.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.3.4 Sample Calculation

OSD VOC = (# employees in inventory area) / (# employees nation wide) X (national VOC emissions from auto body refinishing) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25 X percent reduction from regulation

Estimated National VOC emissions: 79429.39 tons

Number of Employees Nationwide: 205172

Number of Employees in Franklin County: 70

Activity Days Per Week: 5 days

Seasonal Activity Factor: 0.25

Percent Emissions Reduction from Regulation: 37%

OSD VOC = 70 / 205172 X 79429.39 tons X (2000 lb / 1 ton) / (5 days/week) X (1yr/52 week) X 0.25 / 0.25 X (1 – 0.37) = 131.33 lb/day.

2.3.5 Results

Table 1: VOC emissions from Auto Body Refinishing.

County	# Employees	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	70	131.33	N/A
Jefferson	208	390.23	N/A
St. Charles	258	484.04	N/A
St. Louis	933	1750.42	N/A
St. Louis City	398	746.69	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Auto Body Refinishing.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	129.30	141.12	152.94
Jefferson	395.89	429.82	463.76
St. Charles	495.77	622.03	735.07
St. Louis	1750.42	1861.00	1919.04
St. Louis City	742.07	729.20	735.12

2.3.6 References

- *Auto Body Refinishing*, Volume III: Chapter 13, External Draft, Area Sources Committee EIIP, January 1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- U.S. Census Bureau, Department of Commerce, Washington, D.C.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.4 Graphic Arts

2.4.1 Source Description and Emission Control

Graphic arts is considered a solvent evaporation source of VOC emissions and includes the printing of news letters, books, magazines, fabric, wall covering and other materials. Graphic arts operations are performed on printing presses that are made up of one or more "units". Each unit can print only one color. The substrate in graphic arts operations is either continuous and called a "web," or individual pieces of substrate called "sheets." The pattern that is printed on the substrate is called the "image." Five basic processes are used in the printing industry, including flexography, letterpress, lithography, rotogravure, and screen process printing. Considerable emissions originate from minor graphic arts applications, including in-house services in nonprinting industries. The predominant emissions from graphic arts printing are VOC contained in the printing inks, fountain solutions and cleaning solutions. Emissions from proofing presses, cleaning operations, ink storage tanks, and ink mixing operations are relatively minor compared to the emissions during the printing process, but they do contribute to overall emissions.

Afterburners, both thermal and catalytic, can be used to control VOC emissions from the heatset web offset lithography, rotogravure printing, and flexography. Refrigeration of the dampening solution is a process change that can achieve approximately 40 percent reduction of the VOC emissions. The use of lower- VOC-containing cleaning solutions can reduce VOC and hazardous air pollutants (HAP) emissions from cleaning operations in all types of printing. Storing cleaning rags in closed containers can control some of the fugitive emissions from cleaning.

2.4.2 Emissions Estimation Methodology

2.4.2.1 Activity Level

Ink sales nationwide were used to estimate emission from this source category. Ink sales in pounds were obtained from the U.S. Bureau of Census web site. The procedure to estimate emissions from this source category is outlined in EIIP, volume III, Graphic Arts. Given the time limitation and available resources, the first alternative method was used.

2.4.2.2 Emission Factors

The following emission Factors were obtained from EIIP, volume III, Graphic Arts.

Printing Type	% Printing Type	Component Emission Factors Pound VOC Emitted per Pound of Ink Used		
		Ink	Fountain Solution	Cleaning Solution
Rotogravure	22	0.70	NA	0.03
Flexography	16	0.60	NA	0.04
Offset Lithography	35	0.38	2.75	1.23
Letter Press	8	0.24	NA	0.07
Screen	19	0.12	NA	

2.4.2.3 Assumptions

Number of employees was assumed to be proportional to ink sales.

2.4.3 Emissions Projection

A discussion about developing growth factors and projecting emission estimates can be found in Section 4 of the EIIP Volume III, Chapter 1, and Introduction to Area Source Emission Inventory Development. Growth Factors came from the Bureau of Economic Analysis (BEA).

Table 1: Growth Factors for Graphic Arts.

County	2000	2007	2014
Franklin	1.003	1.049	1.094
Jefferson	1.003	1.049	1.094
St. Charles	1.003	1.049	1.094
St. Louis	1.003	1.049	1.094
St. Louis City	1.003	1.049	1.094

2.4.4 Sample Calculation

OSD VOC (lb) = (# employees in county – county point source # employees) / total area source # employees X (Total area source ink usage) X ((% rotogravure ink solvent X rotogravure emission factor) + ((% flexography ink solvent X flexography emission factor) + …) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Total Ink Sales in US: 1642500000 lb

Printing Employment in US: 1501714

Printing Employment in State: 43952

Total Ink Sales in State: 48072509.15 lb

Point Source Ink Usage: 45122344.60 lb

Total Area Source Ink Usage: 2950164.54lb

Total Area Source Printing Employment: 21585

Franklin County Printing Employment: 999

Franklin County Point Source Printing Employment: 231

Activity Days Per Week: 5

Seasonal Activity Factor: 0.25

OSD VOC = (999 – 231) / 21585 X 2950164.54 lb X ((0.22 X 0.73) + (0.16 X 0.64) + (0.35 X 4.36) + (0.08 X 0.31) + (0.19 X 0.12)) / (5 days / week) X (1 yr / 52 week) X 0.25 / 0.25 = 741.48 lb/day

2.4.5 Results

Table 1: VOC emissions from Graphic Arts.

County	Ink Sales (lb)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	104968	741.48	N/A
Jefferson	4374	30.89	N/A
St. Charles	77086	544.52	N/A
St. Louis	682563	4821.52	N/A
St. Louis City	525658	3713.17	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Graphic Arts.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	743.93	778.11	810.88
Jefferson	30.99	32.42	33.78
St. Charles	546.32	571.42	595.49
St. Louis	4837.43	5059.70	5272.81
St. Louis City	3725.42	3896.60	4060.72

2.4.6 References

- *Graphic Arts*, Volume III: Chapter 7, Final Report, Area Sources Committee EIIP, November 1996.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- U.S. Bureau of Census, Department of Commerce, Washington, D.C.

2.5 Commercial/Consumer Solvent Use

2.5.1 Source Description and Emission Control

Solvents contained in consumer and commercial products are primarily released during product use. Commercial and consumer products included in this category are:

- Household products
- Toiletries
- Aerosol products
- Rubbing compounds
- Windshield washing fluids
- Polishes and waxes
- Non-industrial adhesive
- Space deodorants
- Moth control
- Laundry detergents and treatment

Organic compounds in these products may act either as the carrier for the active product ingredients or as the active ingredients themselves. The organic compounds may be released to the atmosphere through immediate evaporation of an aerosol spray, evaporation after application or direct release in the gaseous phase.

Potential control strategies for VOC emissions from consumer and commercial products include a change in the application method, product substitution, product reformulation, and directions for use, storage, and disposal.

2.5.2 Emission Estimation Methodology

2.5.2.1 Activity Level

Emissions from consumer and commercial products were estimated using a single per capita emission factor from EIIP volume III, Chapter 5 and population data obtained from the United States Bureau of Census.

2.5.2.2 Emission Factor

The per capita emission factor for commercial and consumer solvent use is 6.06 lbs./capita/yr. The emission factor was adjusted from 7.84 to 6.06 to avoid double counting with pesticide applications.

2.5.2.3 Assumption

VOC emissions are proportional to population. It was assumed that the EPA consumer and commercial products regulation finalized on March, 1996 would reduce emissions by 20%.

2.5.3 Emissions Projection

Since this area source was calculated using a per capita emission factor, the projected population data obtained from East-West Gateway Coordinating Council web site (http://www.ewgateway.org/) was used to calculate the projected emissions.

Table 1: Growth Factors for Commercial/Consumer Solvent Use.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.5.4 Sample Calculation

OSD VOC (lb) = population X emission factor / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25 X Percent Reduction from Regulation

VOC Emission Factor: 6.06 lb/person/yr

Population of Franklin County: 91763

Activity Days Per Week: 7

Seasonal Activity Factor: 0.25

Percent Reduction of Emission from EPA Regulation: 20%

OSD VOC = 91763 persons X 6.06 lb/person/yr / (7 days/week) X (1 yr / 52 week) X 0.25 / 0.25 X (1 – 0.20) = 1222.16 lbs/day

2.5.5 Results

Table 1: VOC Emissions from Commercial/Consumer Solvent Use.

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	1222.16	N/A
Jefferson	195675	2606.14	N/A
St. Charles	272353	3627.38	N/A
St. Louis	998,696	13301.31	N/A
St. Louis City	339316	4519.24	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Commercial/Consumer Solvent Use.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	1211.92	1374.61	1516.72
Jefferson	2607.44	2810.15	3012.85
St. Charles	3667.21	4210.50	4694.67
St. Louis	13367.27	13315.78	13221.08
St. Louis City	4667.90	4691.91	4715.51

2.5.6 References

- *Consumer and Commercial Solvent Use*, Volume III: Chapter 5, Final Report, Area Sources Committee EIIP, August 1996.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*, Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- U.S. Bureau of Census, Department of Commerce, Washington, D.C.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.6. Solvent Cleaning

2.6.1 Source Description and Emission Control

Degreasing operations are considered solvent evaporation emission sources of VOC and employ non-aqueous solvents to remove grease, fats, oil, wax or soil from the surface of metal, glass or plastic articles which are to be electroplated, painted, repaired, inspected, assembled or machined. Degreasing is not associated with any particular industry, but is used in a variety of industries. There are three types of degreasers: small cold cleaners; open top vapor degreasers; and conveyorized degreasers. Open top vapor degreasers and conveyorized degreasers are usually large enough to be considered as point sources of emissions; therefore, only cold cleaners were evaluated for this area source report. Design features that control solvent emissions from batch cold cleaning machines include increased freeboard ration, covers, internal drainage rack, and visible fill line.

2.6.2 Emission Estimation Methodology

2.6.2.1 Activity Level

EIIP Volume III, Chapter 6 discusses several methods that can be used to estimate emissions. Given the available data and time limits, the emission factor alternative method was used.

2.6.2.2 Emission Factor

A per employee emission factor, 87 lb/employee, for total solvent cleaning was used to estimate VOC emissions from solvent cleaning operations.

2.6.2.3 Assumption

A seasonal activity factor of 0.25 and 6 activity days per week were used to account for summer weekday emission estimate according to EIIP volume III. In addition, it was assumed that a 33% and 67% reduction of emissions will take place in 1999 and 2001, respectively, due to the amendment to 10 CSR 10-5.300, Control of Emissions from Solvent Metal Cleaning. This rule requires that only solvents with vapor pressures less than or equal to 2.0 mmHg will be allowed by September 30, 1998. After April 1, 2001, only solvents with vapor pressures less than or equal to 1.0 mmHg will be allowed.

2.6.3 Emissions Projection

Since this area source emissions estimate was calculated using a per capita factor, an applied growth factor to the baseline estimate used to project emissions. The growth factor can be derived using the projected employment data provided by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Solvent Cleaning.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.6.4 Sample Calculation

OSD VOC (lb) = (# employees) X (emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25 X percent reduction

Solvent Cleaning Employment in Franklin County: 9146

Point Source Solvent Cleaning Employment in Franklin County: 1964

Emission Factor: 87 lb/employee/yr

Activity Days Per Week: 6

Seasonal Activity Factor: 0.25

Percent Reduction from Rule: 33%

OSD VOC = (9146 – 1964) employees X (87 lb/employees/yr) / (6 days/week) X (1 yr/52 weeks) X 0.25/0.25 X (1 – 0.33) = 1341.79 lb/day

2.6.5 Results

Table 1: VOC emissions from Solvent Cleaning Use.

County	# Employees	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	7182	1341.79	N/A
Jefferson	4219	788.22	N/A
St. Charles	7736	1445.29	N/A
St. Louis	46718	8728.18	N/A
St. Louis City	21157	3952.70	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Solvent Cleaning Use.

County	**2000**	**2007**	**2014**
	VOC	**VOC**	**VOC**
Franklin	1321.09	951.60	1031.28
Jefferson	799.65	573.00	618.24
St. Charles	1480.30	1225.82	1448.58
St. Louis	8728.18	6124.52	6315.54
St. Louis City	3928.19	2547.67	2568.34

2.6.6 References

- *Solvent Cleaning Use*, Volume III: Chapter 6, Final Report, Area Sources Committee EIIP, September 1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- United States Bureau of Census*,* Department of Commerce, Washington, D.C.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.7 Traffic Markings

2.7.1 Source Description and Emissions Control

Traffic marking operation consists of marking of highway center, edge stripes, and directional markings and painting on other paved and unpaved surfaces, such as markings in parking lots. Materials used for traffic markings include solvent-based paints, water-bared paints, thermoplastics, preformed tapes, field-reacted materials, and permanent markers. Solvent-based formulations of alkyd resins or chlorinated rubber resins are the most commonly used traffic paints. This inventory report focuses on applications of traffic paints that emit a significant quantity of volatile organic compounds (VOCs).

VOC emissions result from the evaporation of organic solvents during and shortly after the application of the marking paint. Three types emit VOCs in appreciable amount are: (a) Non-aerosol traffic paint, (b) Aerosol marking paint, and (c) Performed tapes applied to adhesive primer. VOC emissions can also result from cleaning the striping equipment. Because the use of organic solvents in traffic marking is the primary source of emissions, control techniques for this source category involve either product substitution or product reformulation. Alternative formulations include low-solvent-content coatings, water-based coatings, and plastic-based coatings.

2.7.2 Emission Estimation Methodology

2.7.2.1 Activity Level

The Missouri Department of Transportation (MODOT) keeps records of amount of paint used for traffic coatings in 10 Districts. Since MODOT does not keep records of paint for each county, population figures were used to estimate how much paint was used for each county.

2.7.2.2 Emission Factor

MODOT determined that the average VOC content for the paint it used in 1999 was 0.52 lb/gallon

2.7.2.3 Assumption

According to a national-level survey of traffic coating end users, it was assumed that 5% of traffic coatings in Missouri was done by agencies other than the Department of Transportation.

2.7.3 Emissions Projection

Growth Factors came from the Bureau of Economic Analysis (BEA).

Table 1: Growth Factors for Traffic Markings.

County	2000	2007	2014
Franklin	1.015	1.133	1.248
Jefferson	1.015	1.133	1.248
St. Charles	1.015	1.133	1.248
St. Louis	1.015	1.133	1.248
St. Louis City	1.015	1.133	1.248

2.7.4 Sample Calculation

SOD VOC (lb) = paint used X emission factor / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Paint Used in Franklin County: 5077 gallons/yr

Emission Factor: 0.52 lb/gallon

Activity Days Per Week: 5

Seasonal Activity Factor: 0.33

OSD VOC = 5077 gallons/yr X 0.52 lb/gallon / 5 days/week X 1 yr / 52 week X 0.33 / 0.25 = 13.40 lb/day

2.7.5 Results

Table 1: VOC Emissions from Traffic Markings.

County	Paint (gallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	5077	13.40	N/A
Jefferson	10826	28.58	N/A
St. Charles	15069	39.78	N/A
St. Louis	55255	145.87	N/A
St. Louis City	18773	49.56	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Traffic Markings.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	13.60	15.18	16.72
Jefferson	29.00	32.37	35.66
St. Charles	40.37	45.06	49.64
St. Louis	148.03	165.21	182.08
St. Louis City	50.29	56.13	61.84

2.7.6 References

- *Traffic Markings*, Volume III: Chapter 14, Final Report, Area Sources Committee EIIP, May1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- United States Bureau of Census*,* Department of Commerce, Washington, D.C.
- Customer Service Center, Department of Transportation, Jefferson City, MO.

2.8 Bakeries

2.8.1 Source Description and Emission Control

The major pollutants emitted from bread baking are VOC emissions, chiefly the ethanol produced as a byproduct of the leavening process. Commercial bread bakeries use four basic dough processes: sponge and dough, straight dough, liquid ferment methods, and no-time dough. Bread in its simplest form requires four ingredients: flour, water, yeast, and salt. The primary emission source at a bakery is the oven. Because the ethanol produced by yeast metabolism is generally liquid at temperature below 77 ^{o}C or 170 ^{o}F, it is not emitted in appreciable amounts until the dough is exposed to high temperature in the oven. Bakery products that are not leavened with yeast do not produce ethanol and should not be considered for the VOC inventory.

2.8.2 Emission Estimation Methodology

2.8.2.1 Activity Level

VOC emissions from bakeries in Missouri counties were estimated using an employment based emission factor. This emission factor encompasses emissions from liquid ferment, sponge and dough methods. The total amount VOC emitted by each county was calculated by multiplying the emission factor with the number of employees. The employees for each county were based on the SIC numbers 2051 and 5461 and obtained from the U.S. Census Bureau.

2.8.2.2 Emission Factor

The emission factor of 220 tons VOC per employee-year was derived by Radian Corporation in the 1980's

2.8.2.3 Assumption

It was assumed that bakery production does not vary from season to season and that the activity days per week are 6 days.

2.8.3 Emissions Projection

A discussion about developing growth factors and projecting emission estimates can be found in Section 4 of the EIIP Volume III, Chapter 1, and Introduction to Area Source Emission Inventory Development. The growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Bakeries.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.8.4 Sample Calculation

OSD VOC (lb) = (# employees - # point source employees) X (emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Bakeries Employment in Franklin County: 10 employees

Bakeries Point Source Employment in Franklin County: 0

Emission Factor: 220 lb/employee/yr

Activity Days Per Week: 6 days

Seasonal Activity Factor: 0.25

OSD VOC = (10 – 0) employees X (220 lb/employee/yr) / (6 days/week) X (1 yr / 52 week) X 0.25 / 0.25 = 7.05 lb/day

2.8.5 Results

Table 1: VOC Emissions from Bakeries.

County	# Employees	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	10	7.05	N/A
Jefferson	19	13.40	N/A
St. Charles	130	91.67	N/A
St. Louis	1785	1258.65	N/A
St. Louis City	391	275.71	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Bakeries.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	6.94	7.58	8.21
Jefferson	13.59	14.76	15.92
St. Charles	93.89	117.80	139.21
St. Louis	1258.65	1338.17	1379.90
St. Louis City	274.00	269.25	271.44

2.8.6 References

- *Baked Goods at Commercial/Retail Bakeries*, Volume III: Area Source Method Abstracts, Area Sources Committee EIIP, July1999.
- U.S. Bureau of Census, Department of Commerce, Washington, D.C.
- Compilation of Air Pollution Emission Factors. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- East-West Coordinating Council, St. Louis City, MO.

2.9 Pesticide Application

2.9.1 Source Description and Emission Control

Pesticides are considered an evaporated source of VOC emission and are defined as any substance used to kill or retard the growth of insects, rodents, fungi, weeds or microorganism. Pesticides can be broken down into three chemical categories: synthetics, non-synthetics (petroleum products), and inorganic. Formulations of pesticides are made through the combination of the pest-killing material referred to as the active ingredient, and various solvents, which act as carriers for the pest-killing material, referred to as the inert ingredient. Both types of ingredients contain volatile organic compounds (VOC) that can potentially be emitted to the air either during application or as result of evaporation. The VOC emission rate is influenced by the formulation (solid or solution) and method of application. Pesticide application can be broken down into two users categories: Agricultural and non-agricultural, which includes municipal, commercial, and consumer.

2.9.2 Emission Estimation Methodology

2.9.2.1 Activity Level

<u>Non-agricultural Pesticides:</u>

Due to difficulties in obtaining accurate information related to non-agricultural pesticides, this category was not separated into municipal, commercial, and consumer subcategories. Emissions were estimated using alternative method 1 given in EIIP, volume III, chapter 9. The method is based on population.

<u>Agricultural Pesticides:</u>

The preferred method was used to estimate emissions form agricultural pesticide. The method is based on pesticide applied, the formulation of the pesticide, and the total acres to which the pesticide was applied. The acreage devoted to crops (alfalfa, corn, cotton, pasture, rice, sorghum, soybeans, tobacco, and wheat) for all counties in 1999 was determined from the state Department of Agricultural (State Crop Statistics, 1999). Pesticide usage data was obtained from the National Center for Food and Agriculture Policy (NCFAP) via the Internet. The data included the pesticide used for each crop, the number of acres treated, and the amount of active ingredient in each pesticide for 1992. Percent active ingredients and VOC contents ware obtained from Chemical & Pharmaceutical Press, Inc. via the Internet.

2.9.2.2 Emission Factors

<u>Non-agricultural Pesticides:</u>

The emission factor for non-agricultural pesticides is 1.78 pound per person. This emission factor encompasses emissions from municipal, commercial, and consumer pesticide use and was taken from Table 5.4-1 of Chapter 5 (Consumer Solvent Use) of EIIP volume III.

Agricultural Pesticides**:**

Emission factors are functions of application method and vapor pressure of pesticide active ingredients. Emission factors and typical vapor pressures for some of the active ingredients are given in tables 9.4-4 and 9.4-2 of EIIP, volume III, Pesticide – Agricultural and Non-agricultural, respectively.

2.9.2.3 Assumptions

It was assumed that the same kinds of pesticides used in 1992 were also used in 1999. It was also assumed that amount of pesticide used in 1999 is 13% more than that of 1992. Missing active ingredients and VOC contents for some the pesticides were assumed to be 50% each.

2.9.3 Emissions Projection

Since this area source emissions estimate was calculated using a per capita factor, the projected population data obtained from East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Pesticide Application.

County	**2000**	**2007**	**2014**
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.9.4 Sample Calculation

OSD VOC (lb) = non-agricultural OSD VOC + agricultural OSD VOC

Non-agricultural Pesticides:

OSD VOC (lb) = population X emission factor / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Population of Franklin County: 91763 persons

Emission Factor: 1.78 lb/person/yr

Activity Days Per Week: 6 days

Seasonal Activity Factor: 0.33

OSD VOC = 91763 persons X 1.78 lb/person/yr / (6 days/week) X (1 yr / 52 weeks) X 0.33/0.25 = 691.05 lbs/day

Agricultural Pesticides:

OSD VOC (lb) = Sum [pesticide applied (lb) X [fraction active ingredient X emission factor + fraction inert ingredient X fraction VOC in formulation] / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25]

Total Pesticides Applied for Sorghum in Missouri

Pesticide	**Acres treated**	**Pounds of active ingredient**
2,4-D	43200	27648
ALACHLOR	122400	210528
ATRAZINE	619200	780192
BROMOXYNIL	7200	2376
GLYPHOSATE	14400	10224
METHOLACHLOR	237600	358776
PROPACHLOR	79200	250272
CARBARYL	36000	36000
CARBOFURAN	28800	24192
CHLORPYRIFOS	14400	10224
DIAZINON	14400	7200
MALATHION	21600	21600
METHOMYL	7200	3600
PHORATE	7200	8064
TERBUFOS	7200	5760
Total	1 260 000 Acres	1 756 656 lbs. AI.

Vapor Pressure of 2,4-D: 8.0×10^{-6}

Application Method: Soil Incorporation

Emission Factor: 5.4 lb/ton

Percent Active Ingredient (%A.I.): 47.9

Percent Inert Ingredient: 52.1

Pesticide Applied: 27648 lb /0.479 X 1.13 = 65223.88 lb

Inert Ingredient VOC Content: 21%

Activity Days Per Week: 6 days

Seasonal Activity Factor: 0.33

OSD VOC from 2,4-D = 65223.88 lb/yr X [0.479 X 5.4 lb/ton X 1 ton/2000 lb + 0.521 X 0.21] / 6 days/week X 1 yr/52 weeks X 0.33/0.25 = 30.55 lb/day
Total OSD VOC from all pesticide applied to Sorghum = 3448.08 lb/day

Total OSD VOC from all pesticide applied to Sorghum in Franklin County = Total OSD VOC X Total Harvested Sorghum Acres in Franklin County / Total Harvested Sorghum Acres in Missouri

Total Harvested Sorghum Acres in Franklin County: 310

Total Harvested Sorghum Acres in Missouri: 310002

OSD VOC = 3448.08 lb/day X 310/310002 = 3.45 lb/day

Total OSD VOC from all pesticide applied to all crops in Franklin County = 296.49 lb/day

Total OSD VOC from Agricultural and Non-agricultural pesticide applied in Franklin County = 232.42 + 691.05 = 923.47 lb/day

2.9.5 Results

Table 1: VOC Emissions from Non-agricultural Pesticides.

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	691.05	N/A
Jefferson	195675	1473.58	N/A
St. Charles	272353	2051.03	N/A
St. Louis	998696	7520.95	N/A
St. Louis City	339316	2555.31	N/A

[1]Ozone Season Day

Table 2: VOC Emissions from Agricultural Pesticides.

County	# Acres	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	102910	232.42	N/A
Jefferson	31910	59.35	N/A
St. Charles	129210	487.39	N/A
St. Louis	22210	75.23	N/A
St. Louis City	0	0	N/A

[1]Ozone Season Day

Table 3: Projected VOC Emissions (lb/day) from Agricultural & Non-agricultural Pesticides.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	915.73	1038.66	1146.04
Jefferson	1533.70	1652.93	1772.16
St. Charles	2566.29	2946.48	3285.30
St. Louis	7633.85	7604.44	7550.36
St. Louis City	2639.37	2652.94	2666.29

2.9.6 References

- *Pesticides- Agricultural & Nonagricultural*, Volume III: Chapter 9, Final Report, Area Sources Committee EIIP, December 1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*, Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- United States Bureau of Census, Department of Commerce, Washington, D.C.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.10 On-site incineration

2.10.1 Source Description and Emission Control

On-site incineration of solid waste is considered a combustion source of VOC, NOx and CO emissions. It is the confined burning of leaves, landscapes refuse or other refuse or rubbish by residential, commercial/institutional and industrial sources. However, it was assumed that only commercial/institutional sources would use on-site incineration, with most residential disposal performed by open burning and industrial sources using landfills.

2.10.2 Emission Estimation Methodology

2.10.2.1 Activity Level

County emissions from on-site incineration were calculated by applying an emission factor to the number of tons burned per year for commercial/institutional sources. The number of tons burned per year was calculated by using average regional factors for the number of tons per 1,000 population per year.

2.10.2.2 Emission Factors

AP-42 emission factors for an industrial/commercial single chamber incinerator were used for commercial/institutional emissions. The AP-42 emission factors for VOC emissions were reported as "represented as methane." Average regional factors used to estimate tons of solid waste burned by on-site incineration in Missouri were obtained from *Procedures for the Preparation of Emission Inventories for Precursors of Ozone: Volume I*. To determine the reactive non-methane VOC, VOC emissions were multiplied by the methane adjustment factor, 0.66.

2.10.2.3 Assumptions

For this inventory study, it was assumed that only commercial/institutional sources would use on-site incineration.

2.10.3 Emissions Projection

A discussion about developing growth factors and projecting emission estimates can be found in Section 4 of the EIIP Volume III, Chapter 1, and Introduction to Area Source Emission Inventory Development. Since the proportion of county to state population was used to estimate this area source emission, the projected emission estimates were calculated using the population-based growth data. The growth factors for population were obtained from East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for On-Site Incineration.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.10.4 Sample Calculation

OSD VOC (lb) = population X waste generation factor X methane adjustment factor X emission factor / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25]

Population of Franklin County: 91763

Waste Generation Factor: 0.037 ton/person/yr

Methane Adjustment Factor: 0.66

VOC Emission Factor: 3 lb/ton

Activity Days Per Week: 7

Seasonal Activity Factor: 0.25

OSD VOC = 91763 persons X 0.037 ton/person/yr X 0.66 X 3 lb/ton / 7 days X 1 yr/52 weeks X 0.25/0.25 = 18.47 lb/day

2.10.5 Results

Table 1: Emissions from On-Site Incineration.

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	18.47	27.98
Jefferson	195675	39.38	59.67
St. Charles	272353	54.81	83.05
St. Louis	998696	201.00	304.55
St. Louis City	339316	68.29	103.47

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from On-Site Incineration.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	18.31	27.75	20.77	31.47	22.92	34.73
Jefferson	39.40	59.70	42.47	64.34	45.53	68.98
St. Charles	55.42	83.97	63.63	96.40	70.94	107.49
St. Louis	202.00	306.06	201.22	304.88	199.79	302.71
St. Louis City	70.54	106.88	70.90	107.43	71.26	107.97

2.10.6 References

- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- East-West Gateway Coordinating Council, St. Louis City, MO.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- United States Bureau of Census, Department of Commerce, Washington, D.C.
- *Procedures for the Preparation of Emission Inventories for Precursors of Ozone:* Volume I, Draft Report, EPA-450/4-91-016, EPA, Research Triangle Park, NC, May 1991.

2.11 Open Burning- Residential Solid Waste

2.11.1 Source Description And Emission Control

The Environmental Protection Agency has informed states, tribal and local agencies that the old methodologies for estimating emissions from open burning have been replaced by new methodologies that exclude commercial/institutional open burning and add open burning from residential leaf & brush burning and land clearing debris burning.

2610030000 Residential Municipal Solid Waste Burning
2610000100 Residential Leaf Burning
2610000400 Residential Brush Burning
2610000500 Land Clearing Debris Burning

Open burning is considered a combustion source of VOC, NOx and CO emissions. Open burning may be done in open drums or baskets, yards or dumps. The most effective control technique of open burning emissions is to ban open burning and require management of these wastes by other methods.

2.11.2 Emission Estimation Methodology

2.11.2.1 Activity Level

Residential Municipal Solid Waste (MSW) Burning

Emission estimates for residential MSW burning were developed by first estimating the amount of waste generated for each county in the United States. The amount of waste generated was estimated using a national average per capita waste generation factor, which is 3.31 lbs/person/day. To better reflect the actual amount of household residential waste subject to being burned, non-combustibles (glass and metals) and yard waste generation were subtracted out. This factor was then applied to the portion of the county's total population that is considered rural based on 1990 Census data on rural and urban population, since open burning is generally not practiced in urban areas.

For rural populations, it is estimated that 25 to 32 percent of the municipal waste generated is burned. A median value of 28 percent was assumed for the nation, and this correction factor was applied to the total amount of waste generated.

Controls (or burning bans) were accounted for by assuming that no burning takes place in counties where the urban population exceeds 80 percent of the total population (i.e., urban plus rural). Zero open burning emissions were attributed to these counties.

Residential Yard Waste Burning

A national per capita waste generation average daily value of 0.56 lbs yard waste/person/day was used as the basis for yard waste open burning emissions for 1999 and 2000. Of the total amount of yard waste generated, the yard waste composition was assumed to be 25 percent leaves, 25 percent brush, and 50 percent grass by weight. Open burning of grass clippings is not typically practiced by homeowners, and as such only estimates for leaf burning and brush burning were developed. Emissions for leaves and residential brush were calculated separately, since emission factors vary by yard waste type. It was assumed that 28 percent of the total yard waste generated is burned and that burning occurs primarily in rural areas.

To adjust for variations in vegetation, obtained data on the percentage of forested acres from Version 2 of the Biogenic Emissions Land cover Database (BELD2) within EPA's Biogenic Emission Inventory System (BEIS). Determined the percentage of forested acres per county (including rural forest and urban forest). To better account for the native vegetation that would likely be occurring in the residential yards of farming States, subtracted out the agricultural lands before calculating the percentage of forested acres. Then used the following ranges to make adjustments to the amount of yard waste that is assumed to be generated per county:

Percent forested acres per county	Adjustment for yard waste generated
< 10%	Zero out
>=10%, and <50%	Multiply by 50%
>=50%	Assume 100%

Controls (or burning bans) were accounted for by assuming that no burning takes place in counties where the urban population exceeds 80 percent of the total population (i.e., urban plus rural). Zero open burning emissions were attributed to these counties.

Land Clearing Debris Burning

The number of acres disturbed by residential, non-residential and roadway construction are estimated and then these values are added together to obtain a county-level estimate of total acres disturbed by land-clearing. County-level emissions from land clearing debris are then calculated by multiplying the total acres disturbed by construction by a weighted loading factor and emission factor.

The BELD2 database in BEIS was used to determine the number of acres of hardwoods, softwoods, and grasses in each county. Average loading factors were weighted according to the percent contribution of each type of vegetation class to the total land area for each county. The loading factors for slash hardwood and slash softwood were further adjusted by a factor of 1.5 to account for the mass of tree that is below the soil surface that would also be subject to burning once the land is cleared. Average loading factors are as follows:

Fuel type	Fuel loading (tons/acre)
Hardwood	99
Softwood	57
Grass	4.5

2.11.2.2 Emission Factors

Emissions factors for VOC and Nox were obtained from AP- 42 (Table 2.5-1).

SCC	Description	VOC	NOx
2610030000	Residential MSW	30	6
2610000100	Yard waste - leaves	28	NA
2610000400	Yard waste - brush	19	NA
2610000500	Land clearing debris	11.6	NA

Ozone Season Daily (OSD) emissions calculated by multiplying annual emissions by 0.25 then dividing by 92.

2.11.2.3 Assumptions

Since there is a rule that prohebits open burning in St. Louis Nonattainment Area during the ozone season, an 80% rule effectiveness was assumed. Note that EPA people did not take into account this rule when they come up with emissions. Therefore, emission in the National Emission Trends web site reflect uncontorled emissions.

2.11.3 Emissions Projection

Since the emissions estimates were derived from waste generation rates that are population dependent, the projected emissions estimates were calculated using the projected population data furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Open Burning (RSW).

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.11.4 Sample Calculation

No sample calulation was provided, becuase EPA generated the results.

2.11.5 Results

Table 1: Emissions from Residential Open Burning

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	268	32
Jefferson	195675	516	48
St. Charles	272353	400	NA
St. Louis	998696	1040	NA
St. Louis City	339316	148	NA

Table 2: Projected Emissions (lb/day) from Residential Open Burning.

County	2000		2007		2014	
	VOC	**NOx**	**VOC**	**NOx**	**VOC**	**NOx**
Franklin	265.75	9.00	301.43	9.00	332.59	9.00
Jefferson	516.26	48.02	556.39	51.76	596.53	55.49
St. Charles	404.39	NA	464.30	NA	517.69	NA
St. Louis	1045.16	NA	1041.13	NA	1033.73	NA
St. Louis City	152.87	NA	153.65	NA	154.43	NA

2.11.6 References

- *Open Burning*, Volume III: Chapter 16, Revised Final, Area Sources Committee EIIP, January 2001.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- *Procedures for the Preparation of Emission Inventories for Precursors of Ozone:* Volume I, Draft Report, EPA-450/4-91-016, EPA, Research Triangle Park, NC, May 1991.
- *Documentation for the Draft 1999 National Emissions Inventory For Criteria Air Pollutants,* Area Sources, E.H. Pechan & Associates, Inc., NC, September 2001.

2.12 Open Burning - Structure Fires

2.12.1 Source Description and Emission Control

Structural fires or building fires are considered a combustion source of VOC, NOx, and CO emissions. Like forest wildfires, they can produce large amounts of emissions over a short period of time.

2.12.2 Emission Estimation Methodology

2.12.2.1 Activity Level

Emissions from structural fires were calculated using the second alternative method in *Procedures for the Preparation of Emission Inventories for Precursors of Ozone: Volume I* where an emission factor is applied to an estimate of the number of fires per county and a fuel loading factor (1.15 tons/fire). The number of fires per county was estimated by assuming that an average of 2.3 fires occur per 1,000 people.

2.12.2.2 Emission Factors

Structural Fire Pollutants	Emission Factor (lbs./ton Material)
VOC	11
CO	60
NOx	1.4

2.12.2.3 Assumptions

The number of fires per county was estimated by assuming that 2.3 fires occur per 1,000 people. According to the EIIP volume III, the seasonal activity factor is 0.2.

2.12.3 Emissions Projection

Since this area source emissions estimation was based on a per capita factor, the population growth was used to develop the projected emissions estimate. The population data and growth factor were obtained from East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Structure Fires.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.12.4 Sample Calculation

OSD VOC (lb) = population X # fires per 1000 people X emission factor X fuel loading factor / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25]

Population of Franklin County: 91763

Number of Fires: 0.0023 fire/person/yr

VOC Emission Factor: 11 lb/ton

Fuel Loading Factor: 1.15 tons/fire

Activity Days Per Week: 7

Seasonal Activity Factor: 0.2

OSD VOC = 91763 persons X 0.0023 fire/person/yr X 11 lb/ton X 1.15 tons/fire / 7 days/week X 1 yr/52 weeks X 0.2/0.25 = 5.87 lb/day

2.12.5 Results

Table 1: Emissions from Structure Fires.

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	5.87	0.75
Jefferson	195675	12.51	1.59
St. Charles	272353	17.42	2.22
St. Louis	998696	63.86	8.13
St. Louis City	339316	21.70	2.76

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from Structure Fires.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	5.82	0.74	6.60	0.84	7.28	0.93
Jefferson	12.52	1.59	13.49	1.71	14.46	1.84
St. Charles	17.61	2.24	20.22	2.58	22.55	2.87
St. Louis	64.18	8.17	63.93	8.14	63.47	8.08
St. Louis City	22.41	2.85	22.53	2.87	22.64	2.88

2.12.6 References

- *Structure Fires*, Volume III: Chapter 18, Final Report, Area Sources Committee EIIP, July 1999.
- *Introduction to Area Source Emission Inventory Development, Volume III: Chapter 1*, Area Sources Committee EIIP, August 1996
- East-West Gateway Coordinating Council, St. Louis City, MO
- U.S. Bureau of Census, Department of Commerce, Washington, D.C.

2.13 Open Burning-Forest/Wild Fires

2.13.1 Source Description and Emission Control

A wildfire is a large-scale natural combustion process that consumes various ages, sizes, and types of flora growing outdoors in a geographical area. Consequently, wildfires are potential sources of large amounts of air pollutants that should be considered when trying to relate emissions to air quality.

The size and intensity, even the occurrence, of a wildfire depend directly on such variables as meteorological conditions, the species of vegetation involved and their moisture content, and the weight of consumable fuel per acre (available fuel loading). Once a fire begins, the dry combustible material is consumed first. If the energy release is large and of sufficient duration, the drying of green, live material occurs, with subsequent burning of this material as well. Under proper environmental and fuel conditions, this process may initiate a chain reaction that results in a widespread conflagration.

The complete combustion of wildland fuels (forests, grasslands, wetlands) require a heat flux (temperature gradient), adequate oxygen supply, and sufficient burning time. The size and quantity of wildland fuels, meteorological conditions, and topographic features interact to modify the burning behavior as the fire spreads, and the wildfire will attain different degrees of combustion efficiency during its lifetime.

This area source inventory will describe the procedures and applied approach for estimating emissions from this area source of forest fires.

2.13.2 Emission Estimation Methodology

2.13.2.1 Activity Level

An alternative method was used rather than the two methods provided in the Wildfires and prescribed Burning, EIIP volume III. County emissions from wildfires were calculated based on an annual report, submitted to the Missouri Department of Conservation, from each county reporting the number of acreage burned.

2.13.2.2 Emission Factors

The following table lists emission factors from the EPA AP-42

Pollutant	Emission Factor (Lbs./ton)	Fuel Loading Factor (tons/acre)
VOC	16	11
NOx	4	11
CO	140	11

2.13.2.3 Assumptions

It is assumed, in proceeding years, the average number of acreage burned based on population growth.

2.13.3 Emissions Projection

Growth Factors came from the Bureau of Economic Analysis (BEA).

Table 1: Growth Factors for Forest/Wild Fires.

County	2000	2007	2014
Franklin	1.000	1.000	1.000
Jefferson	1.000	1.000	1.000
St. Charles	1.000	1.000	1.000
St. Louis	1.000	1.000	1.000
St. Louis City	1.000	1.000	1.000

2.13.4 Sample Calculation

OSD VOC (lb) = # of acreage burned X emission factor X fuel loading factor / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25]

Acres Burned in Franklin County: 1856 acres

VOC Emission Factor: 16 lb/ton

Fuel Loading Factor: 11 tons/acre

Activity Days Per Week: 7

Seasonal Activity Factor: 0.25

OSD VOC = 1856 acres X 16 lb/ton X 11 ton/acre / 7 days/week X 1 yr/52 weeks X 0.25/0.25 = 897.41 lb/day

2.13.5 Results

Table 1: Emissions from Structure Fires.

County	Acres Burned	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	1856	897.41	224.35
Jefferson	943	455.96	113.99
St. Charles	3632	1756.13	439.03
St. Louis	1864	901.27	225.32
St. Louis City	0	0	0

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from Forest/Wild Fires.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	897.41	224.35	897.41	224.35	897.41	224.35
Jefferson	455.96	113.99	455.96	113.99	455.96	113.99
St. Charles	1756.13	439.03	1756.13	439.03	1756.13	439.03
St. Louis	901.27	225.32	901.27	225.32	901.27	225.32
St. Louis City	0	0	0	0	0	0

2.13.6 References

- "Assessment of Biomass Burning in the United States", Bill Leenhouts, U.S. Fish and Wildlife Service, 1998.
- *Compilation of Air Pollution Emission Factors*, Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995

2.14 Gas Distribution

2.14.1 Source Description and Emission Control

Motor gasoline is produced by domestic petroleum refineries or in some cases imported to the United States, and then transported through a distribution network to customers. The distribution network is a complex system that includes many wholesale and retail outlets. The network includes a variety of storage and transfer facilities. Gasoline may be transported by tanker ships and barges, through pipelines or by rail tank cars or tank trucks. This category covers most of those sections of the distribution network where evaporative emissions are usually considered to be area sources. Stage I and Stage II emissions (occurring during the transfer of gasoline from tank trucks to storage tanks at service stations, and subsequent transfer to the vehicle gasoline tank, respectively) are covered, as well as emissions from delivery trucks in transit, gasoline station storage tanks, and spillage.

The area sources of evaporative VOC emissions from the distribution of gasoline that are covered in this chapter include the following:

- Trucks in transit: evaporation of gasoline vapor (1) from loaded tank trucks during transportation of gasoline from the bulk plant/terminal to the service station or other dispensing outlet, and (2) from empty tank trucks returning from service stations to bulk plant/terminals.

- Stage I: displacement of gasoline vapors from the storage tanks during the transfer of gasoline from tank trucks to storage tanks at the service station.

- Stage II: displacement of gasoline vapors from vehicle gasoline tanks during vehicle refueling. This category also may include spillage of gasoline (and subsequent evaporation) during either delivery activity above. This loss includes pre-fill and post-fill nozzle drip and spitback and overflow from the filler pipe of the vehicle's fuel tank during filling.

- Storage tank working losses: evaporation of gasoline vapors from the storage tank and from the lines going to the pumps during transfer of gasoline.

VOC emissions from this area source category are influenced by several factors. Fuel volatility measured as Reid vapor pressure (RVP) affects the evaporation rate of gasoline. The technology for loading tank trucks and tanks (splash loading, submerged loading, vapor balance, etc.) affects the release of displacement emissions. Tank characteristics (color and design) affect working losses from aboveground storage tanks.

Emissions from underground tank filling operations at service stations (stage I emissions) can be reduced by the use of a vapor balance system, which consists of a hose that returns gasoline vapors displaced from the underground tanks during filling back to the tank truck, as well as measures to ensure tightness of the truck. The control efficiency of the balance system can range from 93 to 100 percent. Emissions from vehicle refueling (stage II emissions) also can be reduced by a vapor balance system. During refueling, the vapors displaced from the vehicle fuel tanks are returned to the underground tanks through the use of a special nozzle. Stage 1 controls have been implemented in Kansas City and St. Louis non-attainment area. Stage II controls are required in St. Louis non-attainment area.

2.14.2 Emission Estimation Methodology

2.14.2.1 Activity Level

The first alternative method of Gasoline Distribution, EIIP volume III, was used to estimate VOC emissions. Monthly gasoline distributed in Missouri was obtained from Highway Policy Information, Federal Highway Administration. There was no county-level tax distribution. Therefore, number of gas station in each county was used to allocate gallons of gasoline distributed.

2.14.2.2 Emission Factors

<u>Gasoline truck in transit, fuel delivery to outlets and storage tank breathing emission factors:</u>

Emission Source	**lb/1000 gal. Throughput**
Empty Tank Trucks[b]	0.055
Full Tank Trucks[c]	0.005
Filling Underground Tank (Stage I)	
Submerged Filling	7.3
Splash Filling	11.5
Balanced Submerged Filling	0.3
Underground Tank Breathing	1.0

Source: AP-42 Tables 5.2-5, 5.2-7
b & c , Midpoint to typical range provided in AP-42

<u>Vehicle refueling emission factors:</u>

Mobile 5b was utilized to come up with the vehicle refueling emission factor (6.7682 lb/1000 gallons) for Kansas City Area. Emission factors for the rest of the state were obtained from Fire 6.22. The uncontrolled and controlled emission factors are 11 & 1.1 lb/1000 gallons respectively.

2.14.2.3 Assumptions

It was assumed that rule effectiveness for fuel delivery to outlets and vehicle refueling is 100%. Since gasoline stations have different capacities and demand on gasoline is greater in metropolitan areas, the number of gasoline stations in metropolitan areas was increased by a factor of 1.5.

2.14.3 Emissions Projection

A discussion about developing growth factors and projecting emission estimates can be found in Section 4 of the EIIP Volume III, Chapter 1, and Introduction to Area Source Emission Inventory Development. The growth factors were obtained from the Bureau of Economic Analysis (BEA)

Table 1: Growth Factors for Gasoline Distribution.

County	2000	2007	2014
Franklin	1.012	1.131	1.244
Jefferson	1.012	1.131	1.244
St. Charles	1.012	1.131	1.244
St. Louis	1.012	1.131	1.244
St. Louis City	1.012	1.131	1.244

2.14.4 Sample Calculation

OSD VOC (lb) = [OSD VOC from tank trucks in transit] + [OSD VOC from fuel delivery to outlets] + [OSD VOC from storage tanks breathing] + [OSD VOC from vehicle refueling]

<u>Tank Trucks in Transit:</u>

OSD VOC (lb) = [(total gasoline dispensed in ozone season) X (gasoline transportation adjustment factor) {(loaded tank truck in-transit emission factor) + (unloaded tank truck in-transit emission factor)}] /(1000) / (activity days per week) X (1 yr / 13 weeks)]

Number of Gasoline Stations in Missouri: 3618

Number of Gasoline Stations in Franklin County: 64*1.5 = 96

Total Gasoline Dispensed in Missouri during Ozone Season: 832,511,936 gallons

Total Gasoline Dispensed in Franklin County: 21,049,551.03 gallons

Gasoline Transportation Adjustment Factor: 1.25

Loaded Truck In-Transit Emission Factor: 0.005 lb/1000 gallons

Unloaded Truck In-Transit Emission Factor: 0.055 lb/1000 gallons

Activity Days Per Week: 6

OSD VOC = [21,049,551.03 gallons X 1.25 X {0.005 lb/1000 gallons + 0.055 lb/1000 gallons}] / (1000) / 6 days/week X 1 yr/13 weeks = 20.24 lb/day

<u>Fuel Delivery to Outlets:</u>

OSD VOC (lb) = [(total gasoline dispensed in ozone season) X (fuel delivery to outlets emission factor)]/(1000) / (activity days per week) X (1 yr / 13 weeks)]

Total Gasoline Dispensed in Franklin County: 21,049,551.03 gallons

Fuel Delivery to Outlets Emission Factor (controlled): 0.3 lb/1000 gallons

Activity Days Per Week: 6

OSD VOC = [21,049,551.03 gallons X 0.3 lb/1000 gallons] / (1000) / 6 days/week X 1 yr/13 weeks = 80.96 lb/day

Storage Tanks Breathing:

OSD VOC (lb) = [(total gasoline dispensed in ozone season) X (storage tanks breathing emission factor)]/(1000) / (activity days per week) X (1 yr / 13 week)]

Total Gasoline Dispensed in Franklin County: 21,049,551.03 gallons

Storage Tanks Breathing Emission Factor: 1.0 lb/1000 gallons

Activity Days Per Week: 7

OSD VOC = [21,049,551.03 gallons X 1.0 lb/1000 gallons] / (1000) / 7 days/week X 1 yr/13 weeks = 231.31 lb/day

Vehicle Refueling:

OSD VOC (lb) = [(total gasoline dispensed in ozone season) X (vehicle refueling emission factor)]/(1000) / (activity days per week) X (1 yr / 13 week)]

Total Gasoline Dispensed in Franklin County: 21,049,551.03 gallons

Vehicle Refueling Emission Factor (controlled): 1.1 lb/1000 gallons

Activity Days Per Week: 7

OSD VOC = [21,049,551.03 gallons X 1.1 lb/1000 gallons] / (1000) / 7 days/week X 1 yr/13 weeks = 254.45 lb/day

Total OSD VOC = 20.24 + 80.96 + 231.31 + 254.45 = 586.96 lb/day

2.14.5 Results

Table 1: VOC Emissions from Gasoline Distribution.

County	Gasoline (gallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	21,049,551.03	586.96	N/A
Jefferson	26,640,838.03	742.87	N/A
St. Charles	33,547,721.96	935.47	N/A
St. Louis	121,692,716.91	3393.35	N/A
St. Louis City	43,085,799.77	1201.81	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Gasoline Distribution.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	593.88	663.67	730.00
Jefferson	751.64	839.96	923.91
St. Charles	946.50	1057.73	1163.44
St. Louis	3433.40	3836.87	4220.32
St. Louis City	1215.99	1358.89	1494.69

2.14.6 References

- Highway Policy Information, Federal Highway Administration, U.S. Department of Transportation, Washington, D.C.
- *Gasoline Marketing*, Volume III: Chapter 11, Final Report, Area Sources Committee EIIP, September 1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.

2.15 Coal Combustion

2.15.1 Source Description and Emission Control

Coal is a complex combination of organic matter and inorganic mineral matter formed over eons from successive layers of fallen vegetation. Bituminous coals are by far the largest group and are characterized as having lower fixed carbon and higher volatile matter. This source category covers air emissions from coal combustion in the residential and commercial sectors for space heating or water heating. This category includes small boilers, furnaces, heaters, and other heating units that are not inventoried as point sources. Residential and commercial coal combustion sectors comprise housing units; wholesale and retail businesses; health institutions; social and educational institutions; and Federal, state, and local government institutions. Major Emissions from coal combustion are particulate matter (PM_{10}), sulfur oxides (SOx), and nitrogen oxides (NOx).

2.15.2 Emission Estimation Methodology

2.15.2.1 Activity

The abstract method given in EIIP volume III was used to estimate emissions from coal combustion. This method relied on quantity of coal used and figures of employment using coal as an energy source. Quantities of residential, commercial, and industrial coal used in the inventory area were obtained form U.S. Department of Energy via the Internet.

<u>Residential Sources:</u>

The coal burned at the state level is apportioned to the county level using U.S. Census data on households that use coal as a primary fuel. The equation is:

$$\text{County coal use} = \text{Statewide coal use X } \frac{\text{County coal-burning households}}{\text{State coal-burning households}}$$

<u>Industrial Sources:</u>

The coal burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 20 through 39. The equation is:

$$\text{County coal use} = \text{Statewide coal use X } \frac{\text{SICs 20-39 employees by county}}{\text{SICs 20-39 employees by state}}$$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

<u>Commercial Sources:</u>

The coal burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 50 through 99. The equation is:

$$\text{County coal use} = \text{Statewide coal use} \times \frac{\text{SICs 50-99 employees by county}}{\text{SICs 50-99 employees by state}}$$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

2.15.2.2 Emission Factors

Residential:

Emission factors for VOC, NOx, and CO are presented in Tables 1.1-1 and 1.1-2 along with emission factor ratings from the EPA AP-42. They are 10 lb/ton, 9.1 lb/ton, and 275 lb/ton, respectively.

Commercial:

Emission factors for VOC, NOx, and CO are obtained from FIRE version 6.22. They are 1.3 lb/ton, 9.5 lb/ton, and 11 lb/ton, respectively.

Industrial:

Emission factors for VOC, NOx, and CO are obtained from FIRE version 6.22. They are 0.06 lb/ton, 22 lb/ton, and 0.5 lb/ton, respectively.

2.15.2.3 Assumption

Residential:

Heating degree days in the inventory area were used to estimate emissions during the ozone season. A heating degree day is a measure of the amount of heating necessary for a particular day. One heating degree day is registered for each degree below 65 degree F on a given day. The number of heating degree days for the inventory season and for the entire year were obtained from the National Oceanographic and Atmospheric Administration (NOAA). Average heating degree days are 19 heating degree days, while the average for the whole year is 4581 heating degree days. Therefore, the adjustment factor used for residential coal combustion is 19/4581 = .0041.

2.15.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Residential:

Table 1: Growth Factors for Residential Coal.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

Commercial:

Table 2: Growth Factors for Commercial Coal.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

Industrial:

Table 3: Growth Factors for Industrial Coal.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.15.4 Sample Calculation

Residential Coal:

OSD VOC (lb) = (amount of coal used in Missouri per yr) X (# houses using coal in county) / (# houses using coal in Missouri) X (VOC emission factor) / (activity days per week) X (ozone season / 13 weeks) X (heating degree days/ozone season) / (heating degree days/yr)

Amount of Coal Used in Missouri: 94860 tons

Number of Houses Using Coal in Missouri: 281

Number of Houses Using Coal in Jefferson County: 30

VOC Emission Factor: 10 lb/ton

Activity Days Per Week: 7

Heating Degree Days During Ozone Season: 19

Heating Degree Days During Inventory Year: 4581

OSD VOC = 94860 tons X (30 / 281) X (10 lb/ton) / (7 days/week) X (ozone season/ 13 weeks) X (19 days/ozone season) / (4581 days/yr) = 4.62 lb/day

<u>Commercial Coal:</u>

OSD VOC (lb) = (amount of coal used in Missouri per yr) X (# employees using coal in county) / (# employees using coal in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of Coal Used in Missouri: 159240

Number of Employees Using Coal in Missouri: 1563283

Number of Employees Using Coal in Franklin County: 16281

VOC Emission Factor: 1.3 lb/ton

Activity Days Per Week: 6

Seasonal Activity Factor: 0.15

OSD VOC = 159240 tons X (16281 / 1563283) X (1.3 lb/ton) / (6 days/week) X (1 yr/52 weeks) X 0.15/0.25 = 4.15 lb/day

<u>Industrial Coal:</u>

OSD VOC (lb) = (amount of coal used in Missouri per yr) X (# employees using coal in county) / (# employees using coal in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of Coal Used in Missouri: 1089823 tons

Number of Employees Using Coal in Missouri: 427691

Number of Employees Using Coal in Franklin County: 11064

VOC Emission Factor: 0.06 lb/ton

Activity Days Per Week: 6

Seasonal Activity Factor: 0.25

OSD VOC = 1089823 tons X (11064 / 427691) X (0.06 lb/ton) / (6 days/week) X (1 yr/52 weeks) X 0.25/0.25 = 5.42 lb/day

2.15.5 Results

Residential Coal:

Table 1: Emissions from Residential Coal Combustion.

County	Coal (ton)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	0.00	0.00	0.00
Jefferson	10127.40	4.62	4.20
St. Charles	0.00	0.00	0.00
St. Louis	10464.98	4.77	4.34
St. Louis City	12828.04	5.85	5.32

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from Residential Coal Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	0.00	0.00	0.00	0.00	0.00	0.00
Jefferson	4.62	4.20	4.98	4.53	5.34	4.86
St. Charles	0.00	0.00	0.00	0.00	0.00	0.00
St. Louis	4.79	4.36	4.78	4.34	4.74	4.31
St. Louis City	6.04	5.50	6.07	5.52	6.10	5.55

Commercial Coal:

Table 3: Emissions from Commercial/Institutional Coal Combustion.

County	Coal (ton)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	1658	4.15	30.30
Jefferson	2398	6.00	43.82
St. Charles	5595	13.99	102.21
St. Louis	41505	103.76	758.27
St. Louis City	20460	51.15	373.79

[1]Ozone Season Day

Table 4: Projected Emissions (lb/day) from Commercial/Institutional Coal Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	4.09	29.83	4.46	32.56	4.83	35.29
Jefferson	6.09	44.46	6.61	48.27	7.13	52.08
St. Charles	14.33	104.69	17.98	131.35	21.25	155.22
St. Louis	103.76	758.27	110.32	806.17	113.76	831.32
St. Louis City	50.83	371.47	49.95	365.03	50.36	368.00

Industrial Coal:

Table 5: Emissions from Industrial Coal Combustion.

County	Coal (ton)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	28193	5.42	1987.95
Jefferson	15508	2.98	1093.52
St. Charles	36701	7.06	2587.90
St. Louis	248720	47.83	17537.97
St. Louis City	112012	21.54	7898.27

[1]Ozone Season Day

Table 6: Projected Emissions (lb/day) from Industrial Coal Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	5.34	1957.29	5.82	2136.15	6.31	2315.02
Jefferson	3.02	1109.37	3.28	1204.46	3.54	1299.55
St. Charles	7.23	2650.59	9.07	3325.65	10.72	3930.00
St. Louis	47.83	17537.97	50.85	18645.93	52.44	19227.47
St. Louis City	21.41	7849.30	21.04	7713.26	21.21	7775.84

2.15.6 References

- Energy Information Administration (EIA), U.S. Department of Energy, Washington, D.C.
- The U.S Bureau of Census, Department of Commerce, Washington, D.C.
- National Oceanographic and Atmospheric Administration (NOAA).
- *Residential Commercial/Institutional Coal Combustion*, Volume III: Area Source Method Abstracts, Area Sources Committee EIIP, April 1999.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.16 Liquefied Petroleum Gas (LPG) Combustion

2.16.1 Source Description and Emission Control

LPG consists of propane, propylene, butane, and butylenes; the products used for domestic heating are composed primarily of propane. The largest market for LPG is the domestic/commercial market, followed by the chemical industry (where it is used as a petrochemical feedstock) and the agriculture industry. Propane is also used as an engine fuel as an alternative to gasoline and as a standby fuel for facilities that have interruptible LPG service contracts. LPG is considered a "clean" fuel because it does not produce visible emissions. Gaseous pollutants such as NOx, CO, and organic compounds are produced in small amounts. NOx emissions are a function of a number of variables, including temperature, excess air, fuel, and air mixing, and residence time in the combustion zone. One NOx control system that has been demonstrated on small commercial boilers is Flue Gas Recirculation (FGR).

2.16.2 Emission Estimation Methodology

2.16.2.1 Activity

<u>Residential Sources:</u>

The LPG burned at the state level is apportioned to the county level using U.S. Census data on households that use LPG as a primary fuel. The equation is:

$$\text{County LPG use} = \text{Statewide LPG use} \times \frac{\text{County LPG burning households}}{\text{State LPG burning households}}$$

<u>Industrial sources:</u>

The LPG burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 20 through 39. The equation is:

$$\text{County LPG use} = \text{Statewide LPG use} \times \frac{\text{SICs 20-39 employees by county}}{\text{SICs 20-39 employees by state}}$$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

<u>Commercial Sources:</u>

The LPG burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 50 through 99. The equation is:

County LPG use = Statewide LPG use X $\frac{\text{SICs 50-99 employees by county}}{\text{SICs 50-99 employees by state}}$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

2.16.2.2 Emission Factors

Residential:

Emission factors for VOC, NOx, and CO are presented in Tables 1.5-1 of AP-42. They are 0.5 lb/1000 gallon, 14 lb/1000 gallon, and 1.9 lb/1000 gallon, respectively.

Commercial:

Emission factors for VOC, NOx, and CO are presented in Tables 1.5-1 of AP-42. They are 0.5 lb/1000 gallon, 14 lb/1000 gallon, and 1.9 lb/1000 gallon, respectively.

Industrial:

Emission factors for VOC, NOx, and CO are presented in Tables 1.5-1 of AP-42. They are 0.5 lb/1000 gallon, 19 lb/1000 gallon, and 3.2 lb/1000 gallon, respectively.

2.16.2.3 Assumptions

Residential:

The activity days per week and seasonal activity factor are 7 and 0.08, respectively.

Commercial:

The activity days per week and seasonal activity factor are 6 and 0.15, respectively.

Industrial:

The activity days per week and seasonal activity factor are 6 and 0.25, respectively.

2.16.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Residential:

Table 1: Growth Factors for Residential LPG.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

Commercial:

Table 2: Growth Factors for Commercial LPG.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

Industrial:

Table 3: Growth Factors for Industrial LPG.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.16.4 Sample Calculation

Residential LPG:

OSD VOC (lb) = (amount of LPG used in Missouri per yr) X (# houses using LPG in county) / (# houses using LPG in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of LPG Used in Missouri: 297738 Mgallons

Number of Houses Using LPG in Missouri: 236021

Number of Houses Using LPG in Franklin County: 7394

VOC Emission Factor: 0.5 lb/1000 gallon

Activity Days Per Week: 7

Seasonal Activity Factor: 0.08

OSD VOC = 297738 Mgallons X (7394 / 236021) X (0.5 lb/1000gallon) / (7 days/week) X (1 yr/52 weeks) X 0.08/0.25 = 4.10 lb/day

<u>Commercial LPG:</u>

OSD VOC (lb) = (amount of LPG used in Missouri per yr) X (# employees using LPG in county) / (# employees using LPG in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of LPG Used in Missouri: 51540 Mgallons

Number of Employees Using LPG in Missouri: 1563283

Number of Employees Using LPG in Franklin County: 16281

VOC Emission Factor: 0.5 lb/1000 gallon

Activity Days Per Week: 6

Seasonal Activity Factor: 0.15

OSD VOC = 51540 Mgallons X (16281 / 1563283) X (0.5 lb/1000 gallon) / (6 days/week) X (1 yr/52 weeks) X 0.15/0.25 = 0.52 lb/day

<u>Industrial LPG:</u>

OSD VOC (lb) = (amount of LPG used in Missouri per yr) X (# employees using LPG in county) / (# employees using LPG in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of LPG Used in Missouri: 147081 Mgallons

Number of Employees Using LPG in Missouri: 427691

Number of Employees Using LPG in Franklin County: 11064

VOC Emission Factor: 0.5 lb/1000 gallon

Activity Days Per Week: 6

Seasonal Activity Factor: 0.25

OSD VOC = 147081 Mgallons X (11064 / 427691) X (0.5 lb/1000 gallon) / (6 days/week) X (1 yr/52 weeks) X 0.25/0.25 = 6.10 lb/day

2.16.5 Results

Residential LPG:

Table 1: Emissions from Residential LPG Combustion.

County	LPG (Mgallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	9327	4.10	114.80
Jefferson	11939	5.25	146.94
St. Charles	7025	3.09	86.46
St. Louis	5286	2.32	65.05
St. Louis City	1747	0.77	21.50

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from Residential LPG Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	4.07	113.84	4.61	129.12	5.09	142.47
Jefferson	5.25	147.01	5.66	158.44	6.07	169.87
St. Charles	3.12	87.41	3.59	100.36	4.00	111.90
St. Louis	2.33	65.37	2.32	65.12	2.31	64.66
St. Louis City	0.80	22.21	0.80	22.32	0.80	22.43

Commercial LPG:

Table 3: Emissions from Commercial/Institutional LPG Combustion.

County	LPG (Mgallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	537	0.52	14.45
Jefferson	776	0.75	20.90
St. Charles	1811	1.74	48.75
St. Louis	13434	12.92	361.67
St. Louis City	6622	6.37	178.29

[1]Ozone Season Day

Table 4: Projected Emissions (lb/day) from Commercial/Institutional LPG Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	0.51	14.23	0.56	15.53	0.61	16.83
Jefferson	0.76	21.20	0.83	23.02	0.89	24.84
St. Charles	1.78	49.93	2.24	62.65	2.64	74.03
St. Louis	12.92	361.67	13.74	384.52	14.16	396.51
St. Louis City	6.33	177.18	6.22	174.11	6.27	175.53

Industrial LPG:

Table 5: Emissions from Industrial LPG Combustion.

County	LPG (Mgallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	3805	6.10	231.71
Jefferson	2093	3.35	127.45
St. Charles	4953	7.94	301.63
St. Louis	33567	53.79	2044.13
St. Louis City	15117	24.23	920.58

[1]Ozone Season Day

Table 6: Projected Emissions (lb/day) from Industrial LPG Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	6.01	228.14	6.55	248.98	7.10	269.83
Jefferson	3.40	129.30	3.69	140.38	3.98	151.46
St. Charles	8.13	308.94	10.20	387.62	12.06	458.06
St. Louis	53.79	2044.13	57.19	2173.27	58.97	2241.05
St. Louis City	24.08	914.87	23.66	899.02	23.85	906.31

2.16.6 References

- Energy Information Administration (EIA), U.S. Department of Energy, Washington, D.C.
- The U.S Bureau of Census, Department of Commerce, Washington, D.C.
- *Residential Commercial/Institutional Natural Gas and Liquefied Petroleum Gas (LPG) Combustion*, Volume III: Area Source Method Abstracts, Area Sources Committee EIIP, July 1999.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.17 Natural Gas Combustion

2.17.1 Source Description and Emission Control

Natural gas that is one of the major combustion fuels used throughout the country. It is used to generate industrial and utility electrical power, to produce industrial process steam, and to heat residential and commercial space. Major Emissions from natural gas-fired combustion (e.g., boilers, furnaces, etc.) are particulate matter (PM-10), sulfur oxides (Sox), and nitrogen oxides (NOx). Currently, the two most prevalent combustion control techniques used to reduce NOx emissions are Flue Gas Recirculation (FGR) and low NOx burners. In this category, the emissions inventory is grouped into three combustion sources. They are residential, industrial, and commercial. The emission estimates for each combustion sources follow the same procedures as coal combustion.

2.17.2 Emission Estimation Methodology

2.17.2.1 Activity

Residential Sources:

The natural gas burned at the state level is apportioned to the county level using U.S. Census data on households that use natural gas as a primary fuel. The equation is:

$$\text{County Natural Gas use} = \text{Statewide N. Gas use} \times \frac{\text{County N. Gas burning households}}{\text{State N. Gas burning households}}$$

Industrial sources:

The natural gas burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 20 through 39. The equation is:

$$\text{County Natural Gas use} = \text{Statewide N. Gas use} \times \frac{\text{SICs 20-39 employees by county}}{\text{SICs 20-39 employees by state}}$$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

Commercial Sources:

The natural gas burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 50 through 99. The equation is:

County Natural Gas Use = Statewide Natural Gas use X $\frac{\text{SICs 50-99 employees by county}}{\text{SICs 50-99 employees by state}}$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

2.17.2.2 Emission Factors

Residential:

Emission factors for VOC, NOx, and CO along with emission factor ratings are presented in Tables 1.4-1 through 1.4-4 of AP-42. They are 5.5 lb/MMCF, 84 lb/MMCF, and 40 lb/MMCF, respectively.

Commercial:

Emission factors for VOC, NOx, and CO are obtained from FIRE version 6.22. They are 5.5 lb/MMCF, 100 lb/MMCF, and 84 lb/MMCF, respectively.

Industrial:

Emission factors for VOC, NOx, and CO are obtained from FIRE version 6.22. They are 5.5 lb/MMCF, 140 lb/MMCF, and 84 lb/MMCF, respectively.

2.17.2.3 Assumptions

Residential:

The activity days per week and seasonal activity factor are 7 and 0.08, respectively.

Commercial:

The activity days per week and seasonal activity factor are 6 and 0.15, respectively.

Industrial:

The activity days per week and seasonal activity factor are 6 and 0.25, respectively.

2.17.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Residential:

Table 1: Growth Factors for Residential Natural Gas.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

Commercial:

Table 2: Growth Factors for Commercial Natural Gas.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

Industrial:

Table 3: Growth Factors for Industrial Natural Gas.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.17.4 Sample Calculation

Residential Natural Gas:

OSD VOC (lb) = (amount of N. Gas used in Missouri per yr) X (# houses using N. Gas in county) / (# houses using N. Gas in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of N. Gas Used in Missouri: 112995 MMCF

Number of Houses Using N. Gas in Missouri: 1184863

Number of Houses Using N. Gas in Franklin County: 753

VOC Emission Factor: 5.5 lb/MMCF

Activity Days Per Week: 7

Seasonal Activity Factor: 0.08

OSD VOC = 112995 MMCF X (753 / 1184863) X (5.5 lb/MMCF) / (7 days/week) X (1 yr/52 weeks) X 0.08/0.25 = 0.35 lb/day

<u>Commercial Natural Gas:</u>

OSD VOC (lb) = (amount of N. Gas used in Missouri per yr) X (# employees using N. Gas in county) / (# employees using N. Gas in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of N. Gas Used in Missouri: 60950 MMCF

Number of Employees Using N. Gas in Missouri: 1563283

Number of Employees Using N. Gas in Franklin County: 16281

VOC Emission Factor: 5.5 lb/MMCF

Activity Days Per Week: 6

Seasonal Activity Factor: 0.15

OSD VOC = 60950 MMCF X (16281 / 1563283) X (5.5 lb/MMCF) / (6 days/week) X (1 yr/52 weeks) X 0.15/0.25 = 6.71 lb/day

<u>Industrial Natural Gas:</u>

OSD VOC (lb) = (amount of N. Gas used in Missouri per yr) X (# employees using N. Gas in county) / (# employees using N. Gas in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of N. Gas Used in Missouri: 61064 MMCF

Number of Employees Using N. Gas in Missouri: 427691

Number of Employees Using N. Gas in Franklin County: 11064

VOC Emission Factor: 5.5 lb/MMCF

Activity Days Per Week: 6

Seasonal Activity Factor: 0.25

OSD VOC = 61064 X (11064 / 427691) X (5.5 lb/MMCF) / (6 days/week) X (1 yr/52 weeks) X 0.25/0.25 = 27.85 lb/day

2.17.5 Results

<u>Residential Natural Gas:</u>

Table 1: Emissions from Residential Natural Gas Combustion.

County	Natural Gas (MMCF)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	71.81	0.35	5.93
Jefferson	1691.30	8.18	139.76
St. Charles	4141.61	20.03	342.25
St. Louis	30224.63	164.14	2497.68
St. Louis City	13403.95	64.81	1107.67

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from Residential Natural Gas Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	0.35	5.88	0.39	6.67	0.43	7.36
Jefferson	8.18	139.83	8.82	150.70	9.46	161.57
St. Charles	20.25	346.01	23.25	397.27	25.92	442.95
St. Louis	146.86	2510.07	146.30	2500.40	145.26	2482.61
St. Louis City	66.94	1144.11	67.29	1149.99	67.62	1155.78

<u>Commercial Natural Gas</u>:

Table 3: Emissions from Commercial Natural Gas Combustion.

County	Natural Gas (MMCF)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	634.77	6.71	122.07
Jefferson	918.02	9.71	176.54
St. Charles	2141.40	22.65	411.81
St. Louis	15886.29	168.03	3055.06
St. Louis City	7831.29	82.83	1506.02

[1]Ozone Season Day

Table 4: Projected Emissions (lb/day) from Commercial/Institutional Natural Gas Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	6.61	120.19	7.21	131.17	7.81	142.15
Jefferson	9.85	179.10	10.70	194.45	11.54	209.80
St. Charles	23.20	421.79	29.11	529.21	34.40	625.38
St. Louis	168.03	3055.06	178.65	3248.06	184.22	3349.37
St. Louis City	82.32	1496.68	80.89	1470.74	81.55	1482.67

Industrial Natural Gas:

Table 5: Emissions from Industrial Natural Gas Combustion.

County	Natural Gas (MMCF)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	1579.68	27.85	708.83
Jefferson	868.94	15.32	389.91
St. Charles	2056.41	36.25	922.75
St. Louis	13936.16	245.67	6253.40
St. Louis City	6276.18	110.64	2816.24

[1]Ozone Season Day

Table 6: Projected Emissions (lb/day) from Industrial Natural Gas Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	27.42	697.90	29.93	761.67	32.43	825.45
Jefferson	15.54	395.56	16.87	429.47	18.21	463.37
St. Charles	37.13	945.10	46.58	1185.81	55.05	1401.29
St. Louis	245.67	6253.40	261.19	6648.46	269.34	6855.81
St. Louis City	109.95	2798.78	108.05	2750.27	108.92	2772.58

2.17.6 References

- Energy Information Administration (EIA), U.S. Department of Energy, Washington, D.C.
- The U.S Bureau of Census, Department of Commerce, Washington, D.C.
- *Residential Commercial/Institutional Natural Gas and Liquefied Petroleum Gas Combustion*, Volume III: Area Source Method Abstracts, Area Sources Committee EIIP, July 1999.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.

- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.18 Fuel Oil Combustion

2.18.1 Source Description and Emission Controls

This emission source covers air emissions from the combustion of distillate fuel oils and kerosene by the residential, commercial/institutional and Industrial sectors for space heating, water heating or process heating. This source category includes small boilers, furnaces, heaters, and other heating units that are not inventoried as point sources. Residential and commercial fuel oil and kerosene combustion sectors include housing units; wholesale and retail businesses; health institutions; social and educational institutions; and Federal, state and local government institutions (e.g., military installations, prisons, office buildings).

2.18.2 Emission Estimation Methodology

2.18.2.1 Activity Level

<u>Residential Sources:</u>

The fuel oil burned at the state level is apportioned to the county level using U.S. Census data on households that use fuel oil as a primary fuel. The equation is:

$$\text{County Fuel Oil use} = \text{Statewide Fuel Oil use} \times \frac{\text{County Fuel Oil burning households}}{\text{State Fuel Oil burning households}}$$

<u>Commercial Sources:</u>

The Fuel Oil burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 50 through 99. The equation is:

$$\text{County Fuel Oil use} = \text{Statewide Fuel Oil use} \times \frac{\text{SICs 50-99 employees by county}}{\text{SICs 50-99 employees by state}}$$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

<u>Industrial sources:</u>

The Fuel Oil burned at the state level is apportioned to the county level using U.S. Census data on employment with Standard Industrial Classification (SIC) categories 20 through 39. The equation is:

$$\text{County Fuel Oil Use} = \text{Statewide N. Gas use} \times \frac{\text{SICs 20-39 employees by county}}{\text{SICs 20-39 employees by state}}$$

The employment data can be seen from the publication for the year closest to the inventory year, which can be obtained from the U.S. Department of Commerce, Census Bureau.

2.18.2.2 Emission Factors

Residential:

Emission factors for VOC, NOx, and CO along with emission factor ratings are presented in Tables 1.3-1 through 1.4-3 of AP-42. They are 0.7 lb/1000 gallon, 18 lb/1000 gallon, and 5 lb/1000 gallon, respectively.

Commercial:

Emission factors for VOC, NOx, and CO along with emission factor ratings are presented in Tables 1.3-1 through 1.4-3 of AP-42. They are 0.34 lb/1000 gallon, 20 lb/1000 gallon, and 5 lb/1000 gallon, respectively.

Industrial:

Emission factors for VOC, NOx, and CO along with emission factor ratings are presented in Tables 1.3-1 through 1.4-3 of AP-42. They are 0.2 lb/1000 gallon, 20 lb/1000 gallon, and 5 lb/1000 gallon, respectively.

2.18.2.3 Assumptions

It was assumed that kerosene emission factors are similar to distillate oil emission factors.

Residential:

The activity days per week and seasonal activity factor are 7 and 0.08, respectively.

Commercial:

The activity days per week and seasonal activity factor are 6 and 0.15, respectively.

Industrial:

The activity days per week and seasonal activity factor are 6 and 0.25, respectively.

2.18.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Residential:

Table 1: Growth Factors for Residential Fuel Oil.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

Commercial:

Table 2: Growth Factors for Commercial Fuel Oil.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

Industrial:

Table 3: Growth Factors for Industrial Fuel Oil.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.18.4 Sample Calculation

Residential Fuel Oil:

OSD VOC (lb) = (amount of fuel oil used in Missouri per yr) X (# houses using fuel oil in county) / (# houses using fuel oil in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of Fuel Oil Used in Missouri: 16022 Mgallons

Number of Houses Using Fuel Oil in Missouri: 29457

Number of Houses Using Fuel Oil in Franklin County: 3793

VOC Emission Factor: 0.7 lb/1000 gallons

Activity Days Per Week: 7

Seasonal Activity Factor: 0.08

OSD VOC = 16022 Mgallons X (3793 / 29457) X (0.7 lb/1000 gallon) / (7 days/week) X (1 yr/52 weeks) X 0.08/0.25 = 1.27 lb/day

<u>Commercial Fuel Oil:</u>

OSD VOC (lb) = (amount of fuel oil used in Missouri per yr) X (# employees using fuel oil in county) / (# employees using fuel oil in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of fuel oil Used in Missouri: 53470 Mgallon

Number of Employees Using fuel oil in Missouri: 1563283

Number of Employees Using fuel oil in Franklin County: 16281

VOC Emission Factor: 0.34 lb/ 1000 gallon

Activity Days Per Week: 6

Seasonal Activity Factor: 0.15

OSD VOC = 53470 Mgallon X (16281 / 1563283) X (0.34 lb/1000 gallon) / (6 days/week) X (1 yr/52 weeks) X 0.15/0.25 = 0.36 lb/day

<u>Industrial Fuel Oil:</u>

OSD VOC (lb) = (amount of fuel oil used in Missouri per yr) X (# employees using fuel oil in county) / (# employees using fuel oil in Missouri) X (VOC emission factor) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

Amount of Fuel Oil Used in Missouri: 161389 Mgallon

Number of Employees Using Fuel Oil in Missouri: 427691

Number of Employees Using Fuel Oil in Franklin County: 11064

VOC Emission Factor: 0.2 lb/1000 gallon

Activity Days Per Week: 6

Seasonal Activity Factor: 0.25

OSD VOC = 161389 Mgallon X (11064 / 427691) X (0.2 lb/1000 gallon) / (6 days/week) X (1 yr/52 weeks) X 0.25/0.25 = 2.68 lb/day

2.18.5 Results

<u>Residential Fuel Oil:</u>

Table 1: Emissions from Residential Fuel Oil Combustion.

County	Fuel Oil (Mgallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	2063	1.27	32.65
Jefferson	1222	0.75	19.33
St. Charles	990	0.61	15.67
St. Louis	2117	1.30	33.50
St. Louis City	1311	0.81	20.75

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from Residential Fuel Oil Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	1.26	32.38	1.43	36.72	1.58	40.52
Jefferson	0.75	19.34	0.81	20.84	0.87	22.35
St. Charles	0.62	15.84	0.71	18.19	0.79	20.28
St. Louis	1.31	33.67	1.30	33.54	1.29	33.30
St. Louis City	0.84	21.43	0.84	21.54	0.85	21.65

<u>Commercial Fuel Oil</u>:

Table 3: Emissions from Commercial Fuel Oil Combustion.

County	Fuel Oil (Mgallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	557	0.36	21.42
Jefferson	805	0.53	30.98
St. Charles	1879	1.23	72.25
St. Louis	13937	9.11	536.02
St. Louis City	6870	4.49	264.24

[1]Ozone Season Day

Table 4: Projected Emissions (lb/day) from Commercial/Institutional Fuel Oil Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	0.35	21.09	0.39	23.02	0.42	24.94
Jefferson	0.54	31.43	0.58	34.12	0.63	36.82
St. Charles	1.26	74.00	1.58	92.85	1.87	109.72
St. Louis	9.11	536.02	9.69	569.88	9.99	587.66
St. Louis City	4.46	262.60	4.38	258.05	4.42	260.14

Industrial Fuel Oil:

Table 5: Emissions from Industrial Fuel Oil Combustion.

County	Fuel Oil (Mgallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	4175.00	2.68	267.63
Jefferson	2296.55	1.47	147.21
St. Charles	5434.98	3.48	348.40
St. Louis	36832.41	23.61	23.61.05
St. Louis City	16587.56	10.63	1063.31

[1]Ozone Season Day

Table 6: Projected Emissions (lb/day) from Industrial Fuel Oil Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	2.64	263.50	2.88	287.58	3.12	311.66
Jefferson	1.49	149.34	1.62	162.14	1.75	174.95
St. Charles	3.56	356.84	4.47	447.72	5.28	529.08
St. Louis	23.61	2361.05	25.10	2510.21	25.88	2588.50
St. Louis City	10.56	1056.72	10.38	1038.40	10.47	1046.83

2.18.6 References

- Energy Information Administration (EIA), U.S. Department of Energy, Washington, D.C.
- The U.S Bureau of Census, Department of Commerce, Washington, D.C.
- *Residential Commercial/Institutional Fuel Oil Combustion*, Volume III: Area Source Method Abstracts, Area Sources Committee EIIP, April 1999.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- Eat-West Gateway Coordinating Council, St. Louis City, MO.

2.19 Wood Combustion – Residential

2.19.1 Source Description and Emission Controls

This area source category of residential wood combustion is defined as wood burning that takes place primarily in woodstoves and fireplaces. Residential wood burning takes place either as a necessary source of heat or for aesthetics. Fireplaces can be divided into 2 broad categories: (1) masonry (generally brick and/or stone, assembled on site, and integral to a structure) and (2) factory-built (usually metal, installed on site as a package with appropriate ductwork). Woodstoves are commonly used in residences as space heaters. They are used both as the primary source of residential heat and to supplement conventional heating systems. There are five different woodstove categories:

- The conventional woodstove;
- The catalytic woodstove;
- The noncatalytic woodstove;
- The pellet stove; and
- The masonry heater.

Pollutants emitted from residential wood combustion include particulate mater (PM), volatile organic compounds (VOC), nitrogen oxides (NOx), carbon monoxide (CO), and hazardous air pollutants (HAP).

Controls for this category may be use of new technology woodstoves, improvements in wood burning performance, use of “no burn” periods, public awareness and educational programs, replacement or installation of gas-burning equipment in fireplaces, and total banning of burning.

2.19.2 Emission Estimation Methodology

2.19.2.1 Activity

The amount of residential wood used in Missouri was obtained from the Energy Information Administration. Then, this amount was apportioned to county level using the number of houses that use wood as a source of heat.

2.19.2.2 Emission Factors

The emission factors for estimating emissions from residential wood combustion were obtained from the EIIP Volume III, Chapter 2 “Residential Wood Combustion”. Since information about different woodstove types is not available and no distinction has been made between fireplaces and wood stoves, the emission factors used for wood combustion are those for fireplaces. The table below lists criteria pollutant emission factors for residential wood combustion (lb/ton).

Process Description	Criteria Pollutant Emission Factors				
	PM	NOx	CO	VOC	SOx
Residential Fireplaces	34.6	2.6	252.6	229.0	0.4

2.19.2.3 Assumptions

It was assumed that there was not significant industrial and commercial wood combustion. The calculations were based strictly on residential consumption data. Seasonal activity is based on the number of heating degree-days in season. This information was obtained from the National Oceanographic and Atmospheric Administration (NOAA).

2.19.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Residential Wood.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.19.4 Sample Calculation

OSD VOC (lb) = (amount of wood used in Missouri per yr) X (# houses burning wood in county) / (# houses burning wood in Missouri) X (VOC emission factor) / (activity days per week) X (ozone season / 13 weeks) X (heating degree days/ozone season) / (heating degree days/yr)

Amount of Wood Used in Missouri: 814077 tons

Number of Houses Burning Wood in Missouri: 148772

Number of Houses Burning Wood in Franklin County: 3474

VOC Emission Factor: 229 lb/ton

Activity Days Per Week: 7

Heating Degree Days During Ozone Season: 19

Heating Degree Days During Inventory Year: 4581

OSD VOC = 814077 tons/yr X (3474 / 148772) X (229 lb/ton) / (7 days/week) X (ozone season/ 13 weeks) X (19 days/ozone season) / (4581 days/yr) = 198.41 lb/day

2.19.5 Results

Table 1: Emissions from Residential Wood Combustion.

County	Wood (Ton)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	19009.65	198.41	2.25
Jefferson	16394.04	171.11	1.94
St. Charles	7857.76	82.01	0.93
St. Louis	7414.53	77.39	0.88
St. Louis City	1274.97	13.31	0.15

[1]Ozone Season Day

Table 2: Projected Emissions (lb/day) from Residential Wood Combustion.

County	2000		2007		2014	
	VOC	NOx	VOC	NOx	VOC	NOx
Franklin	196.75	2.23	223.16	2.53	246.23	2.79
Jefferson	171.20	1.94	184.50	2.09	197.81	2.24
St. Charles	82.91	0.94	95.19	1.08	106.14	1.20
St. Louis	77.77	0.88	77.47	0.88	76.92	0.87
St. Louis City	13.75	0.15	13.82	0.16	13.89	0.16

2.19.6 References

- Energy Information Administration (EIA), U.S. Department of Energy, Washington, D.C.
- The U.S Bureau of Census, Department of Commerce, Washington, D.C.
- National Oceanographic and Atmospheric Administration (NOAA).
- *Residential Wood Combustion*, Volume III: Chapter 2, Final Report, Area Sources Committee EIIP, September 1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.20 Asphalt Paving

2.20.1 Source Description and Emission Controls

Asphalt paving is used to pave, seal, and repair surfaces such as roads, parking lots, drives, walkways, and airport runways. Asphalt concrete used in paving is a mixture of asphalt cement, which is a binder, and an aggregate. Asphalt cement is the semi-solid residual material left from petroleum refining after the lighter and more volatile fractions have been distilled out. Hot-mix asphalt is a mixture of heated asphalt cement and aggregate. Asphalt cutbacks are asphalt cements thinned with petroleum distillates (diluents). Asphalt emulsions are mixtures of asphalt cement with water and emulsifiers. Aggregates used in asphalt cements are typically rock gravel or recycled asphalt pavement, but can also be byproducts from metal ore refining processes. Aggregate may constitute up to 95 percent by weight of the total mixture. Mixture characteristics for asphalt concrete are determined by the amount and grade of asphalt cement used, the addition of solvent- or soap-based liquefying agents, and the relative amount and types of aggregate used.

Recycled asphalt pavement (RAP) is being used more frequently, partly as a move to reduce solid waste. One source estimates that 90 percent of asphalt processed is RAP. To reuse the asphalt, the RAP is typically pulverized; sorted; mixed with recycling agents such as lime or calcium chloride, or additional aggregate; then applied. The five methods of recycling are: cold planing, hot recycling, hot in-place recycling, cold in-place recycling, and full depth reclamation. All except hot recycling occur at the location where paving is to be done, although material removed during cold planing may be processed at an asphalt plant.

Asphalt concrete is grouped into three general categories: hot-mix, cutback, and emulsified. Each is discussed below.

<u>Hot-Mix Asphalt:</u>

Hot-mix asphalt is the most commonly used paving asphalt for surfaces of 2 to 6 inches thick. Hot-mix asphalt is prepared at a hot-mix asphalt plant by heating asphalt cement before adding the aggregate. To maintain a liquid mixture, these plants must be near to the paving site. In some cases, mobile facilities are used.

<u>Cutback Asphalt:</u>

Cutback asphalt is used in tack and seal operations, in priming roadbeds for hot-mix application, and for paving operations for pavements up to several inches thick. In preparing cutback asphalt, asphalt cement is blended or “cut back” with a diluent, typically from 25 to 45 percent by volume of petroleum distillates, depending on the desired viscosity. Cutback asphalt is prepared at an asphalt plant. There are three types of cutback asphalt cement:

- Rapid Cure (RC) which uses gasoline or naphthas as diluents;
- Medium Cure (MC) which uses kerosene as a diluent; and
- Slow Cure (SC) which uses low volatility fuel solvents as diluents.

Emulsified Asphalt:

Emulsified asphalt is used in most of the same applications as cutback asphalts but is a lower emitting, energy saving, and safer alternative to the cutback asphalts. Instead of blending asphalt cement with petroleum distillates, emulsified asphalts use a blend of asphalt cement, water and an emulsifying agent, such as soap. Such blends typically contain one-third water, two-thirds asphalt cement and minor amounts of an emulsifier. Some emulsified asphalts may contain up to 12 percent organic solvents by volume. Emulsification is done at an asphalt plant. Emulsified asphalts cure by two methods: water evaporation and, in the case of cationic and anionic emulsions, ionic bonding.

2.20.2 Emission Estimation Methodology

2.20.2.1 Activity Level

Amounts of cutback and emulsified asphalts used in Missouri were obtained from Missouri Department of Transportation. Amounts of asphalts used in each county were not available. Instead, Missouri Department of Transportation gave amounts of asphalts used in 10 districts. For example, district 6, which contains Franklin, Jefferson, St. Charles, St. Louis counties and St. Louis City, used 36000 gallons of cutback asphalt in 1999. Population was used to distribute amounts of asphalt used among counties.

2.20.2.2 Emission Factor

Missouri Department provided all Safety Material Data Sheets (MSDSs) for all types of asphalt used in 1999. Alternative Method 1 of EIIP volume III, Asphalt Paving, was used to come up with emission factors for the different types of asphalt.

2.20.2.3 Assumption

It was assumed that 5% of asphalt paving was conducted by agencies other than the state's Department of Transportation. After some search on asphalt application practices, it was determined that cutback asphalt is typically applied during November through March. Moreover, emulsified asphalt is typically applied only in worm weather. This corresponds to the months of May through September. Example 17.3.1 of the EIIP Asphalt document indicated that 66% of the application occurs during the ozone months. Since there is a rule that bans applying cutback asphalt during ozone season in St. Louis Area, it was assumed that there is 80% compliance with this rule.

2.20.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Asphalt Paving.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.20.4 Sample Calculation

Cutback Asphalt:

OSD VOC (lb) = amount of cutback asphalt (gallons) X population of county / population of district X volume % of diluent X density of diluent X weight % of diluent evaporated / (activity days per week) X (1 yr / 39 week) X (seasonal activity factor) / 0.25 X Rule Effectiveness

Population of Buchanan County: 81776

Population of District 1: 195286

Types of Asphalt Used in District 1: MC-250 & 800

Amount of MC-250 & 800 Used in District 1: 116739 gallons

Volume Percent of Diluent: 19%

MC Diluent Density: 6.6755 lb/gallon

Weight Percent Diluent Evaporated: 70%

Activity Days Per Week: 5

Seasonal Activity Factor: 0.25

Rule Effectiveness: 0%

OSD VOC = 116739 gallons X 81776 / 195286 X 0.19 X 6.6755 lb/gallon X 0.7 / 5 days/week X 1 yr/39 weeks X 0.25/0.25 = 222.57 lb/day

Emulsified Asphalt:

OSD VOC (lb) = amount of emulsified asphalt (gallons) X % of asphalt applies in ozone season X population of county / population of district X volume % of diluent X density of diluent X weight % of diluent evaporated / (activity days per week) X (ozone season / 13 week)

Population Of St. Louis County: 998696

Population of District 6: 1897803

Types of Asphalt Used in District 6: CRS-2

Amount of CRC-2 Used in District 6: 104959.05 gallons

Volume Percent of Diluent: 2.5%

CRS-2 Diluent Density: 7.5 lb/gallon

Weight Percent Diluent Evaporated: 95%

Activity Days Per Week: 7

OSD VOC = 104959.05 gallons X 998696 / 1897803 X 0.66 X 0.025 X 7.5 lb/gallon X 0.95 / 7 days/week X 1 ozone season/13 weeks = 71.36 lb/day

2.20.5 Results

Table 1: VOC Emissions from Cutback Asphalt.

County	Cutback Asphalt (gallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	1827.71	1.73	N/A
Jefferson	3897.41	3.70	N/A
St. Charles	5424.66	5.15	N/A
St. Louis	19891.80	18.87	N/A
St. Louis City	6758.42	6.41	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Cutback Asphalt.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	1.72	1.95	2.15
Jefferson	3.70	3.99	4.28
St. Charles	5.21	5.98	6.67
St. Louis	18.96	18.89	18.76
St. Louis City	6.62	6.65	6.69

Table 3: VOC Emissions from Emulsified Asphalt.

County	Emulsified Asphalt (gallon)	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	5075.00	6.56	N/A
Jefferson	10821.91	13.98	N/A
St. Charles	15062.63	19.46	N/A
St. Louis	55233.44	71.36	N/A
St. Louis City	18766.06	24.24	N/A

[1]Ozone Season Day

Table 4: Projected VOC Emissions (lb/day) from Emulsified Asphalt.

County	2000	2007	2014
	VOC	**VOC**	**VOC**
Franklin	6.51	7.38	8.14
Jefferson	13.99	15.07	16.16
St. Charles	19.67	22.59	25.19
St. Louis	71.71	71.44	70.93
St. Louis City	25.04	25.17	25.29

2.20.6 References

- *Asphalt Paving*, Volume III: Chapter 17, Final Report, Area Sources Committee EIIP, October 1998.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- Customer Service Center, Department of Transportation, Jefferson City, MO.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.21 Landfills

2.21.1 Source Description and Emission Control

Landfills are significant sources of methane (CH_4) and carbon dioxide (CO_2). In addition to CH4 and CO_2 a small amount of non-methane organic compounds (NMOCs) are produced. NMOCs include reactive volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). Unlike other area sources that may be small sources individually but numerous within the inventory area, only a few landfills may be found within a multi-county area. However, each landfill may emit significant amounts of pollutants. Landfills differ from sources typically categorized as point or major sources in that pollutants are emitted over the area of the landfill, not at a specific point or points. For these reasons, landfills have been treated as area sources in the past. Recently, air-operating permits have been required for landfills, so that inventory preparers have begun to address them as point sources.

A municipal solid waste (MSW) landfill unit is a discrete area of land or an excavation that receives household waste, commercial solid waste, nonhazardous sludge, and industrial solid waste.

2.21.2 Emission Estimation Methodology

2.21.2.1 Activity Level

The emissions from municipal landfills were estimated by using the population-based waste generation factor. Although landfills can generate emissions for many years, the greatest emissions were assumed to be within a period of 25 years.

2.21.2.2 Emission Factors

The waste generation factor (1.02 ton/person/year) was obtained form the Solid Waste Program publications.

2.21.2.3 Assumptions

It was assumed that the greatest emissions from landfills occur within a period of 25 years.

2.21.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Landfills.

County	2000	2007	2014
Franklin	-0.838%	12.474%	24.101%
Jefferson	0.050%	7.828%	15.606%
St. Charles	1.098%	16.075%	29.423%
St. Louis	0.496%	0.109%	-0.603%
St. Louis City	3.290%	3.821%	4.343%

2.21.4 Sample Calculations

A landfill spreadsheet developed by the Air Pollution Control Program (APCP) was used to calculate VOC emissions from landfills. Since the calculation is long, it was decided to keep the calculation sample in the spreadsheet.

2.21.5 Results

Table 1: VOC Emissions from Landfills.

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	51.89	N/A
Jefferson	195675	108.21	N/A
St. Charles	272353	127.02	N/A
St. Louis	998,696	518.28	N/A
St. Louis City	339316	274.67	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Landfills.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	51.46	58.36	64.40
Jefferson	108.26	116.68	125.10
St. Charles	128.41	147.44	164.39
St. Louis	520.85	518.84	515.15
St. Louis City	283.71	285.16	286.60

2.21.6 References

- *Municipal Landfills*, Volume III: Chapter 15, Final Report, Area Sources Committee EIIP, September 1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.

- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- East-West Gateway Coordinating Council, St. Louis City, MO.

2.22 Industrial Surface Coating

2.22.1 Source Description and Emission Control

"Surface coating operations involve applying a thin layer of coating (e.g., paint, lacquer, enamel, varnish, etc.) to an object for decorative or protective purposes. The surface coating products include either a water-based or solvent-based liquid carrier that generally evaporates in the drying or curing process.

The use of surface coatings by manufacturing industries and other sectors of the economy is pervasive. Applications include: (1) coatings that are applied during the manufacture of a wide variety of products by Original Equipment Manufacturers (OEMs) including furniture, cans, automobiles, other transportation equipment, machinery, appliances, metal coils, flat wood, wire, and other miscellaneous products, (2) architectural coatings, and (3) special purpose coatings used for applications such as maintenance operations at industrial and other facilities, auto refinishing, traffic paints, marine finishes, and aerosol sprays. For area source purposes, the small industrial surface coating category includes OEM applications, some marine coatings, and maintenance coatings. This category does not include architectural surface coatings, traffic markings, automobile refinishing, or aerosols.

The main approaches for reducing VOC emissions from small industrial surface coating operations are (1) use of lower-VOC coatings, (2) use of enclosed cleaning devices, and (3) increased transfer efficiency. Other housekeeping activities can also be used to reduce emissions from small industrial surface coating operations. These activities include using tight-fitting containers, reducing spills, mixing paint to need, providing operator training, maintaining rigid control of inventory, using proper cleanup methods, etc.

2.22.2 Emission Estimation Methodology

2.22.2.1 Activity Level

Alternative Method 1 of EIIP volume III, Industrial Surface Coating, was used to estimate VOC emissions. This method is based on the national default per employee emission factors presented in Table 8.5-1 of EIIP volume III, Industrial Surface Coating.

2.22.2.2 Emission Factors

The following table represents emission factors based on SIC:

Category	SIC Code	Per Employee VOC Emission Factor (lb/yr)
Furniture and Fixtures	25	944
Metal Containers	341	6,029
Automobiles (new)	3711	794
Machinery and Equipment	35	77
Appliances	363	463
Other Transportation Equipment	37, except 3711 and 373	35
Sheet, Strip, and Coil	3479	2,877
Factory Finished Wood	2426-9, 243-245, 2493, 2499	131
Electrical Insulation	3357, 3612	290
Other Product Coatings	NA[a]	NA
High-Performance Maintenance Coatings	NA	NA
Marine Coatings	373	308
Other Special Purpose Coatings	NA	NA

[a]NA = not available, use per capita emission factors from Table 8.5-2

2.22.2.3 Assumptions

All industrial surface coatings are accounted for in the point source inventory.

2.22.3 Emissions Projection

Emission growth factors were furnished by East-West Gateway Coordinating Council web site (http://www.ewgateway.org/).

Table 1: Growth Factors for Industrial Surface Coating.

County	2000	2007	2014
Franklin	-1.542%	7.455%	16.452%
Jefferson	1.449%	10.145%	18.841%
St. Charles	2.422%	28.508%	51.860%
St. Louis	0.000%	6.318%	9.633%
St. Louis City	-0.620%	-2.342%	-1.550%

2.22.4 Sample Calculations

OSD VOC (lb) = Σ ((SIC # employees from county business Patterns – SIC # employees from point source) X SIC emission factor)) + (county population X other population based emission factors) / (activity days per week) X (1 yr / 52 week) X (seasonal activity factor) / 0.25

2.22.5 Results

Table 1: VOC Emissions from Industrial Surface Coating.

County	Population	VOC Emissions OSD[1] (Lb/Day)	NOx Emissions OSD[1] (Lb/Day)
Franklin	91763	0	N/A
Jefferson	195675	0	N/A
St. Charles	272353	0	N/A
St. Louis	998,696	0	N/A
St. Louis City	339316	0	N/A

[1]Ozone Season Day

Table 2: Projected VOC Emissions (lb/day) from Industrial Surface Coating.

County	2000	2007	2014
	VOC	VOC	VOC
Franklin	0	0	0
Jefferson	0	0	0
St. Charles	0	0	0
St. Louis	0	0	0
St. Louis City	0	0	0

2.22.6 References

- *Industrial Surface Coating*, Volume III: Chapter 15, Final Report, Area Sources Committee EIIP, September 1997.
- *Introduction to Area Source Emission Inventory Development*, Volume III: Chapter 1, Area Sources Committee EIIP, August 1996.
- *Compilation of Air Pollution Emission Factors*. Volume I: Stationary Point and Area Sources. AP-42 (Fifth Edition), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, January 1995.
- East-West Gateway Coordinating Council, St. Louis City, MO.

3.0 Emissions Summary

On a typical summer weekday, 56.993 tons of volatile organic compounds (VOC) are emitted from area sources in four counties (Franklin, Jefferson, St. Charles, St. Louis) and St. Louis City that make up the St. Louis Metropolitan Statistical Area (MSA). Area source emissions of oxides of nitrogen (NOx) from the St. Louis MSA total 32.243 tons per summer weekday. Tables 3.1 through 3.4 shows 1999, 2000, 2007, and 2014 VOC and NOx emissions from St. Louis MSA.

Table 3.1: 1999 Base Year VOC & NOx Emissions

County	VOC Emissions OSD (Ton/Day)	NOx Emissions OSD (Ton/Day)
Franklin	3.829	1.913
Jefferson	4.935	1.283
St. Charles	7.881	2.883
St. Louis	29.144	18.024
St. Louis City	11.204	8.141
Total	**56.993**	**32.243**

Table 3.2: 2000 Projection Year VOC & NOx Emissions

County	VOC Emissions OSD (Ton/Day)	NOx Emissions OSD (Ton/Day)
Franklin	3.806	1.886
Jefferson	4.951	1.298
St. Charles	7.972	2.944
St. Louis	29.260	18.031
St. Louis City	11.392	8.115
Total	**57.380**	**32.273**

Table 3.3: 2007 Projection Year VOC & NOx Emissions

County	VOC Emissions OSD (Ton/Day)	NOx Emissions OSD (Ton/Day)
Franklin	3.939	2.052
Jefferson	5.191	1.402
St. Charles	8.795	3.609
St. Louis	28.387	19.065
St. Louis City	10.877	7.989
Total	**57.188**	**34.117**

Table 3.2: 2014 Projection Year VOC & NOx Emissions

County	VOC Emissions OSD (Ton/Day)	NOx Emissions OSD (Ton/Day)
Franklin	4.262	2.217
Jefferson	5.565	1.507
St. Charles	9.757	4.204
St. Louis	28.757	19.600
St. Louis City	11.078	8.052
Total	**59.419**	**35.580**

Return to Appendix

Missouri Department of Natural Resources
Air Pollution Control Program

NOx - Population, Employment & BEA

FIPS	SCC	Description	Pollutant	Emissions	2000 Emissions	2007 Emissions	2014 Emissions
071	2102002000	Industrial Coal	NOX	1987.950	1987.950	1987.950	1987.950
071	2102004000	Industrial Fuel Oil	NOX	267.630	267.630	267.630	267.630
071	2102006000	Industrial Natural Gas	NOX	708.830	708.830	708.830	708.830
071	2102007000	Industrial LPG	NOX	231.710	231.710	231.710	231.710
071	2103002000	Commercial/Institutional Coal	NOX	30.300	30.300	30.300	30.300
071	2103004000	Commercial/Institutional Fuel Oil	NOX	21.420	21.420	21.420	21.420
071	2103006000	Commercial/Institutional Natural Gas	NOX	122.070	122.070	122.070	122.070
071	2103007000	Commercial/Institutional LPG	NOX	14.450	14.450	14.450	14.450
071	2104002000	Residential Coal	NOX	0.000	0.000	0.000	0.000
071	2104004000	Residential Fuel Oil	NOX	32.650	32.650	32.650	32.650
071	2104006000	Residential Natural Gas	NOX	5.930	5.930	5.930	5.930
071	2104007000	Residential LPG	NOX	114.800	114.800	114.800	114.800
071	2104008001	Residential Wood	NOX	2.250	2.250	2.250	2.250
071	2601020000	On-site Incineration	NOX	27.983	27.983	27.983	27.983
071	2810001000	Forest/Wild Fires	NOX	224.350	224.350	224.350	224.350
071	2810030000	Structure Fires	NOX	0.750	0.750	0.750	0.750
071	2610030000	Open Burning	NOX	32.000	32.000	32.000	32.000
099	2102002000	Industrial Coal	NOX	1093.520	1093.520	1093.520	1093.520
099	2102004000	Industrial Fuel Oil	NOX	147.210	147.210	147.210	147.210
099	2102006000	Industrial Natural Gas	NOX	389.910	389.910	389.910	389.910
099	2102007000	Industrial LPG	NOX	127.450	127.450	127.450	127.450
099	2103002000	Commercial/Institutional Coal	NOX	43.820	43.820	43.820	43.820
099	2103004000	Commercial/Institutional Fuel Oil	NOX	30.980	30.980	30.980	30.980
099	2103006000	Commercial/Institutional Natural Gas	NOX	176.540	176.540	176.540	176.540
099	2103007000	Commercial/Institutional LPG	NOX	20.900	20.900	20.900	20.900
099	2104002000	Residential Coal	NOX	4.200	4.200	4.200	4.200
099	2104004000	Residential Fuel Oil	NOX	19.330	19.330	19.330	19.330
099	2104006000	Residential Natural Gas	NOX	139.760	139.760	139.760	139.760
099	2104007000	Residential LPG	NOX	146.940	146.940	146.940	146.940
099	2104008001	Residential Wood	NOX	1.940	1.940	1.940	1.940
099	2601020000	On-site Incineration	NOX	59.670	59.670	59.670	59.670
099	2810001000	Forest/Wild Fires	NOX	113.990	113.990	113.990	113.990
099	2810030000	Structure Fires	NOX	1.590	1.590	1.590	1.590
099	2610030000	Open Burning	NOX	48.000	48.000	48.000	48.000
183	2102002000	Industrial Coal	NOX	2587.900	2587.900	2587.900	2587.900
183	2102004000	Industrial Fuel Oil	NOX	348.400	348.400	348.400	348.400
183	2102006000	Industrial Natural Gas	NOX	922.750	922.750	922.750	922.750
183	2102007000	Industrial LPG	NOX	301.630	301.630	301.630	301.630
183	2103002000	Commercial/Institutional Coal	NOX	102.210	102.210	102.210	102.210
183	2103004000	Commercial/Institutional Fuel Oil	NOX	72.250	72.250	72.250	72.250
183	2103006000	Commercial/Institutional Natural Gas	NOX	411.810	411.810	411.810	411.810
183	2103007000	Commercial/Institutional LPG	NOX	48.750	48.750	48.750	48.750
183	2104002000	Residential Coal	NOX	0.000	0.000	0.000	0.000
183	2104004000	Residential Fuel Oil	NOX	15.670	15.670	15.670	15.670
183	2104006000	Residential Natural Gas	NOX	342.250	342.250	342.250	342.250
183	2104007000	Residential LPG	NOX	86.460	86.460	86.460	86.460
183	2104008001	Residential Wood	NOX	0.930	0.930	0.930	0.930
183	2601020000	On-site Incineration	NOX	83.053	83.053	83.053	83.053
183	2810001000	Forest/Wild Fires	NOX	439.030	439.030	439.030	439.030
183	2810030000	Structure Fires	NOX	2.220	2.220	2.220	2.220

189	2102002000	Industrial Coal	NOX	17537.970	17537.970	17537.970	17537.970
189	2102004000	Industrial Fuel Oil	NOX	2361.050	2361.050	2361.050	2361.050
189	2102006000	Industrial Natural Gas	NOX	6253.400	6253.400	6253.400	6253.400
189	2102007000	Industrial LPG	NOX	2044.130	2044.130	2044.130	2044.130
189	2103002000	Commercial/Institutional Coal	NOX	758.270	758.270	758.270	758.270
189	2103004000	Commercial/Institutional Fuel Oil	NOX	536.020	536.020	536.020	536.020
189	2103006000	Commercial/Institutional Natural Gas	NOX	3055.060	3055.060	3055.060	3055.060
189	2103007000	Commercial/Institutional LPG	NOX	361.670	361.670	361.670	361.670
189	2104002000	Residential Coal	NOX	4.340	4.340	4.340	4.340
189	2104004000	Residential Fuel Oil	NOX	33.500	33.500	33.500	33.500
189	2104006000	Residential Natural Gas	NOX	2497.680	2497.680	2497.680	2497.680
189	2104007000	Residential LPG	NOX	65.050	65.050	65.050	65.050
189	2104008001	Residential Wood	NOX	0.880	0.880	0.880	0.880
189	2601020000	On-site Incineration	NOX	304.547	304.547	304.547	304.547
189	2810001000	Forest/Wild Fires	NOX	225.320	225.320	225.320	225.320
189	2810030000	Structure Fires	NOX	8.130	8.130	8.130	8.130
510	2102002000	Industrial Coal	NOX	7898.270	7898.270	7898.270	7898.270
510	2102004000	Industrial Fuel Oil	NOX	1063.310	1063.310	1063.310	1063.310
510	2102006000	Industrial Natural Gas	NOX	2816.240	2816.240	2816.240	2816.240
510	2102007000	Industrial LPG	NOX	920.580	920.580	920.580	920.580
510	2103002000	Commercial/Institutional Coal	NOX	373.790	373.790	373.790	373.790
510	2103004000	Commercial/Institutional Fuel Oil	NOX	264.240	264.240	264.240	264.240
510	2103006000	Commercial/Institutional Natural Gas	NOX	1506.020	1506.020	1506.020	1506.020
510	2103007000	Commercial/Institutional LPG	NOX	178.290	178.290	178.290	178.290
510	2104002000	Residential Coal	NOX	5.320	5.320	5.320	5.320
510	2104004000	Residential Fuel Oil	NOX	20.750	20.750	20.750	20.750
510	2104006000	Residential Natural Gas	NOX	1107.670	1107.670	1107.670	1107.670
510	2104007000	Residential LPG	NOX	21.500	21.500	21.500	21.500
510	2104008001	Residential Wood	NOX	0.150	0.150	0.150	0.150
510	2601020000	On-site Incineration	NOX	103.473	103.473	103.473	103.473
510	2810001000	Forest/Wild Fires	NOX	0.000	0.000	0.000	0.000
510	2810030000	Structure Fires	NOX	2.760	2.760	2.760	2.760
		TOTAL (lbs)		64485.516	64485.516	64485.516	64485.516
		TOTAL (tons)		32.243	32.243	32.243	32.243
					0.000	0.000	0.000

Return to Appendix

Missouri Department of Natural Resources
Air Pollution Control Program

VOC - Population, Employment & BEA

FIPS	SCC	Description	Pollutant	Emissions	2000 Emissions	2007 Emissions	2014 Emissions
071	2102002000	Industrial Coal	VOC	5.420	5.420	5.420	5.420
071	2102004000	Industrial Fuel Oil	VOC	2.680	2.680	2.680	2.680
071	2102006000	Industrial Natural Gas	VOC	27.850	27.850	27.850	27.850
071	2102007000	Industrial LPG	VOC	6.100	6.100	6.100	6.100
071	2103002000	Commercial/Institutional Coal	VOC	4.150	4.150	4.150	4.150
071	2103004000	Commercial/Institutional Fuel Oil	VOC	0.360	0.360	0.360	0.360
071	2103006000	Commercial/Institutional Natural Gas	VOC	6.710	6.710	6.710	6.710
071	2103007000	Commercial/Institutional LPG	VOC	0.520	0.520	0.520	0.520
071	2104002000	Residential Coal	VOC	0.000	0.000	0.000	0.000
071	2104004000	Residential Fuel Oil	VOC	1.270	1.270	1.270	1.270
071	2104006000	Residential Natural Gas	VOC	0.350	0.350	0.350	0.350
071	2104007000	Residential LPG	VOC	4.100	4.100	4.100	4.100
071	2104008001	Residential Wood	VOC	198.410	198.410	198.410	198.410
071	2302050000	Bakeries	VOC	7.050	7.050	7.050	7.050
071	2401001000	Architectural Coating	VOC	1076.460	1076.460	1076.460	1076.460
071	2401005000	Auto-body Refinishing	VOC	131.330	131.330	131.330	131.330
071	2401008000	Traffic Markings	VOC	13.400	13.598	15.177	16.721
071	2401015000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401020000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401040000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401050000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401055000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401060000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401065000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401070000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401080000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401090000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401100000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2401200000	Industrial Surface Coating	VOC		0.000	0.000	0.000
071	2415000000	Solvent Cleaning	VOC	1341.789	1341.789	885.581	885.581
071	2420000000	Drycleaning	VOC	106.615	106.615	106.615	106.615
071	2425000000	Graphic Arts	VOC	741.480	743.927	778.109	810.883
071	2460000000	Consumer/Commercial Solvent Use	VOC	1222.160	1222.160	1222.160	1222.160
071	2461021000	Cutback Asphalt	VOC	1.730	1.730	1.730	1.730
071	2461022000	Emulsified Asphalt	VOC	6.560	6.560	6.560	6.560
071	2461800000	Pesticide	VOC	923.470	923.470	923.470	923.470
071	2501060050	Gasoline Stage I	VOC	101.200	102.394	114.427	125.862
071	2501060100	Gasoline Stage II	VOC	254.445	257.448	287.701	316.453
071	2501060201	Gasoline Tank Breathing Loss	VOC	231.314	234.043	261.546	287.685
071	2.6E+09	On-site Incineration	VOC	18.469	18.469	18.469	18.469
071	2620030000	Municipal Landfills	VOC	51.890	51.890	51.890	51.890
071	2810001000	Forest/Wild Fires	VOC	897.410	897.410	897.410	897.410
071	2810030000	Structure Fires	VOC	5.870	5.870	5.870	5.870
071	2610000100	Open Burning	VOC	8.000	8.000	8.000	8.000
071	2610000400	Open Burning	VOC	4.000	4.000	4.000	4.000
071	2610000500	Open Burning	VOC	100.000	100.000	100.000	100.000
071	2610030000	Open Burning	VOC	156.000	156.000	156.000	156.000
099	2102002000	Industrial Coal	VOC	2.980	2.980	2.980	2.980
099	2102004000	Industrial Fuel Oil	VOC	1.470	1.470	1.470	1.470

099	210200600(	Industrial Natural Gas	VOC	15.320	15.320	15.320	15.320
099	210200700(	Industrial LPG	VOC	3.350	3.350	3.350	3.350
099	210300200(	Commercial/Institutional Coal	VOC	6.000	6.000	6.000	6.000
099	210300400(	Commercial/Institutional Fuel Oil	VOC	0.530	0.530	0.530	0.530
099	210300600(	Commercial/Institutional Natural Gas	VOC	9.710	9.710	9.710	9.710
099	210300700(	Commercial/Institutional LPG	VOC	0.750	0.750	0.750	0.750
099	210400200(	Residential Coal	VOC	4.620	4.620	4.620	4.620
099	210400400(	Residential Fuel Oil	VOC	0.750	0.750	0.750	0.750
099	210400600(	Residential Natural Gas	VOC	8.180	8.180	8.180	8.180
099	210400700(	Residential LPG	VOC	5.250	5.250	5.250	5.250
099	210400800′	Residential Wood	VOC	171.110	171.110	171.110	171.110
099	230205000(	Bakeries	VOC	13.400	13.400	13.400	13.400
099	240100100(	Architectural Coating	VOC	2295.440	2295.440	2295.440	2295.440
099	240100500(	Auto-body Refinishing	VOC	390.235	390.235	390.235	390.235
099	240100800(	Traffic Markings	VOC	28.580	29.003	32.370	35.662
099	240101500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240102000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240104000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240105000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240105500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240106000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240106500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240107000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240108000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240109000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240110000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	240120000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
099	241500000(	Solvent Cleaning	VOC	788.222	788.222	520.226	520.226
099	242000000(	Drycleaning	VOC	62.308	62.308	62.308	62.308
099	242500000(	Graphic Arts	VOC	30.890	30.992	32.416	33.781
099	246000000(	Consumer/Commercial Solvent Use	VOC	2606.136	2606.136	2606.136	2606.136
099	246102100(	Cutback Asphalt	VOC	3.700	3.700	3.700	3.700
099	246102200(	Emulsified Asphalt	VOC	13.980	13.980	13.980	13.980
099	246180000(	Pesticide	VOC	1532.930	1532.930	1532.930	1532.930
099	250106005(	Gasoline Stage I	VOC	128.081	129.592	144.821	159.294
099	250106010(	Gasoline Stage II	VOC	322.032	325.832	364.122	400.511
099	250106020′	Gasoline Tank Breathing Loss	VOC	292.756	296.211	331.020	364.101
099	2.6E+09	On-site Incineration	VOC	39.382	39.382	39.382	39.382
099	262003000(	Municipal Landfills	VOC	108.210	108.210	108.210	108.210
099	281000100(	Forest/Wild Fires	VOC	455.960	455.960	455.960	455.960
099	281003000(	Structure Fires	VOC	12.510	12.510	12.510	12.510
099	261000010(	Open Burning	VOC	8.000	8.000	8.000	8.000
099	261000040(	Open Burning	VOC	8.000	8.000	8.000	8.000
099	261000050(	Open Burning	VOC	252.000	252.000	252.000	252.000
099	261003000(	Open Burning	VOC	248.000	248.000	248.000	248.000
183	210200200(	Industrial Coal	VOC	7.060	7.060	7.060	7.060
183	210200400(	Industrial Fuel Oil	VOC	3.480	3.480	3.480	3.480
183	210200600(	Industrial Natural Gas	VOC	36.250	36.250	36.250	36.250
183	210200700(	Industrial LPG	VOC	7.940	7.940	7.940	7.940
183	210300200(	Commercial/Institutional Coal	VOC	13.990	13.990	13.990	13.990
183	210300400(	Commercial/Institutional Fuel Oil	VOC	1.230	1.230	1.230	1.230
183	210300600(	Commercial/Institutional Natural Gas	VOC	22.650	22.650	22.650	22.650
183	210300700(	Commercial/Institutional LPG	VOC	1.740	1.740	1.740	1.740
183	210400200(	Residential Coal	VOC	0.000	0.000	0.000	0.000
183	210400400(	Residential Fuel Oil	VOC	0.610	0.610	0.610	0.610

183	210400600(	Residential Natural Gas	VOC	20.030	20.030	20.030	20.030
183	210400700(	Residential LPG	VOC	3.090	3.090	3.090	3.090
183	210400800´	Residential Wood	VOC	82.010	82.010	82.010	82.010
183	230205000(	Bakeries	VOC	91.670	91.670	91.670	91.670
183	240100100(	Architectural Coating	VOC	3194.940	3194.940	3194.940	3194.940
183	240100500(	Auto-body Refinishing	VOC	484.042	484.042	484.042	484.042
183	240100800(	Traffic Markings	VOC	39.780	40.369	45.055	49.637
183	240101500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240102000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240104000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240105000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240105500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240106000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240106500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240107000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240108000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240109000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240110000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	240120000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
183	241500000(	Solvent Cleaning	VOC	1445.291	1445.291	953.892	953.892
183	242000000(	Drycleaning	VOC	279.692	279.692	279.692	279.692
183	242500000(	Graphic Arts	VOC	544.521	546.318	571.420	595.488
183	246000000(	Consumer/Commercial Solvent Use	VOC	3627.384	3627.384	3627.384	3627.384
183	246102100(	Cutback Asphalt	VOC	5.150	5.150	5.150	5.150
183	246102200(	Emulsified Asphalt	VOC	19.460	19.460	19.460	19.460
183	246180000(	Pesticide	VOC	2538.420	2538.420	2538.420	2538.420
183	250106005(	Gasoline Stage I	VOC	161.287	163.190	182.367	200.593
183	250106010(	Gasoline Stage II	VOC	405.522	410.307	458.524	504.348
183	250106020´	Gasoline Tank Breathing Loss	VOC	368.656	373.006	416.840	458.498
183	2.6E+09	On-site Incineration	VOC	54.815	54.815	54.815	54.815
183	262003000(	Municipal Landfills	VOC	127.020	127.020	127.020	127.020
183	281000100(	Forest/Wild Fires	VOC	1756.130	1756.130	1756.130	1756.130
183	281003000(	Structure Fires	VOC	17.420	17.420	17.420	17.420
183	261000050(	Open Burning	VOC	400.000	400.000	400.000	400.000
189	210200200(	Industrial Coal	VOC	47.830	47.830	47.830	47.830
189	210200400(	Industrial Fuel Oil	VOC	23.610	23.610	23.610	23.610
189	210200600(	Industrial Natural Gas	VOC	245.670	245.670	245.670	245.670
189	210200700(	Industrial LPG	VOC	53.790	53.790	53.790	53.790
189	210300200(	Commercial/Institutional Coal	VOC	103.760	103.760	103.760	103.760
189	210300400(	Commercial/Institutional Fuel Oil	VOC	9.110	9.110	9.110	9.110
189	210300600(	Commercial/Institutional Natural Gas	VOC	168.030	168.030	168.030	168.030
189	210300700(	Commercial/Institutional LPG	VOC	12.920	12.920	12.920	12.920
189	210400200(	Residential Coal	VOC	4.770	4.770	4.770	4.770
189	210400400(	Residential Fuel Oil	VOC	1.300	1.300	1.300	1.300
189	210400600(	Residential Natural Gas	VOC	146.140	146.140	146.140	146.140
189	210400700(	Residential LPG	VOC	2.320	2.320	2.320	2.320
189	210400800´	Residential Wood	VOC	77.390	77.390	77.390	77.390
189	230205000(	Bakeries	VOC	1258.650	1258.650	1258.650	1258.650
189	240100100(	Architectural Coating	VOC	11715.570	11715.570	11715.570	11715.570
189	240100500(	Auto-body Refinishing	VOC	1750.417	1750.417	1750.417	1750.417
189	240100800(	Traffic Markings	VOC	145.870	148.029	165.212	182.017
189	240101500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240102000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240104000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240105000(	Industrial Surface Coating	VOC		0.000	0.000	0.000

189	240105500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240106000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240106500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240107000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240108000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240109000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240110000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	240120000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
189	241500000(	Solvent Cleaning	VOC	8728.177	8728.177	5760.597	5760.597
189	242000000(	Drycleaning	VOC	1866.462	1866.462	1866.462	1866.462
189	242500000(	Graphic Arts	VOC	4821.520	4837.431	5059.703	5272.814
189	246000000(	Consumer/Commercial Solvent Use	VOC	13301.312	13301.312	13301.312	13301.312
189	246102100(	Cutback Asphalt	VOC	18.870	18.870	18.870	18.870
189	246102200(	Emulsified Asphalt	VOC	71.360	71.360	71.360	71.360
189	246180000(	Pesticide	VOC	7596.180	7596.180	7596.180	7596.180
189	250106005(	Gasoline Stage I	VOC	585.061	591.965	661.529	727.641
189	250106010(	Gasoline Stage II	VOC	1471.011	1488.369	1663.272	1829.496
189	250106020´	Gasoline Tank Breathing Loss	VOC	1337.283	1353.063	1512.065	1663.178
189	2.6E+09	On-site Incineration	VOC	201.001	201.001	201.001	201.001
189	262003000(	Municipal Landfills	VOC	518.280	518.280	518.280	518.280
189	281000100(	Forest/Wild Fires	VOC	901.270	901.270	901.270	901.270
189	281003000(	Structure Fires	VOC	63.860	63.860	63.860	63.860
189	261000050(	Open Burning	VOC	1040.000	1040.000	1040.000	1040.000
510	210200200(	Industrial Coal	VOC	21.540	21.540	21.540	21.540
510	210200400(	Industrial Fuel Oil	VOC	10.630	10.630	10.630	10.630
510	210200600(	Industrial Natural Gas	VOC	110.640	110.640	110.640	110.640
510	210200700(	Industrial LPG	VOC	24.230	24.230	24.230	24.230
510	210300200(	Commercial/Institutional Coal	VOC	51.150	51.150	51.150	51.150
510	210300400(	Commercial/Institutional Fuel Oil	VOC	4.490	4.490	4.490	4.490
510	210300600(	Commercial/Institutional Natural Gas	VOC	82.830	82.830	82.830	82.830
510	210300700(	Commercial/Institutional LPG	VOC	6.370	6.370	6.370	6.370
510	210400200(	Residential Coal	VOC	5.850	5.850	5.850	5.850
510	210400400(	Residential Fuel Oil	VOC	0.810	0.810	0.810	0.810
510	210400600(	Residential Natural Gas	VOC	64.810	64.810	64.810	64.810
510	210400700(	Residential LPG	VOC	0.770	0.770	0.770	0.770
510	210400800´	Residential Wood	VOC	13.310	13.310	13.310	13.310
510	230205000(	Bakeries	VOC	275.710	275.710	275.710	275.710
510	240100100(	Architectural Coating	VOC	3980.470	3980.470	3980.470	3980.470
510	240100500(	Auto-body Refinishing	VOC	746.695	746.695	746.695	746.695
510	240100800(	Traffic Markings	VOC	49.560	50.293	56.132	61.841
510	240101500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240102000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240104000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240105000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240105500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240106000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240106500(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240107000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240108000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240109000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240110000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	240120000(	Industrial Surface Coating	VOC		0.000	0.000	0.000
510	241500000(	Solvent Cleaning	VOC	3952.699	3952.699	2608.781	2608.781
510	242000000(	Drycleaning	VOC	472.154	472.154	472.154	472.154
510	242500000(	Graphic Arts	VOC	3713.170	3725.423	3896.601	4060.723

510	246000000(	Consumer/Commercial Solvent Use	VOC	4519.240	4519.240	4519.240	4519.240
510	246102100(	Cutback Asphalt	VOC	6.410	6.410	6.410	6.410
510	246102200(	Emulsified Asphalt	VOC	24.240	24.240	24.240	24.240
510	246180000(	Pesticide	VOC	2555.310	2555.310	2555.310	2555.310
510	250106005(	Gasoline Stage I	VOC	207.143	209.588	234.217	257.624
510	250106010(	Gasoline Stage II	VOC	520.817	526.963	588.888	647.741
510	250106020'	Gasoline Tank Breathing Loss	VOC	473.470	479.057	535.353	588.855
510	250502009(	Marine Vessel	VOC	0.380	0.384	0.430	0.473
510	2.6E+09	On-site Incineration	VOC	68.292	68.292	68.292	68.292
510	262003000(	Municipal Landfills	VOC	274.670	274.670	274.670	274.670
510	281000100(	Forest/Wild Fires	VOC	0.000	0.000	0.000	0.000
510	281003000(	Structure Fires	VOC	21.700	21.700	21.700	21.700
510	261000050(	Open Burning	VOC	148.000	148.000	148.000	148.000
		TOTAL (lbs)		113986.966	114104.532	109879.952	111122.556
		TOTAL (tons)		56.993	57.052	54.940	55.561
					0.001	-0.036	-0.025

Return to Appendix